MARCH 10, 1958
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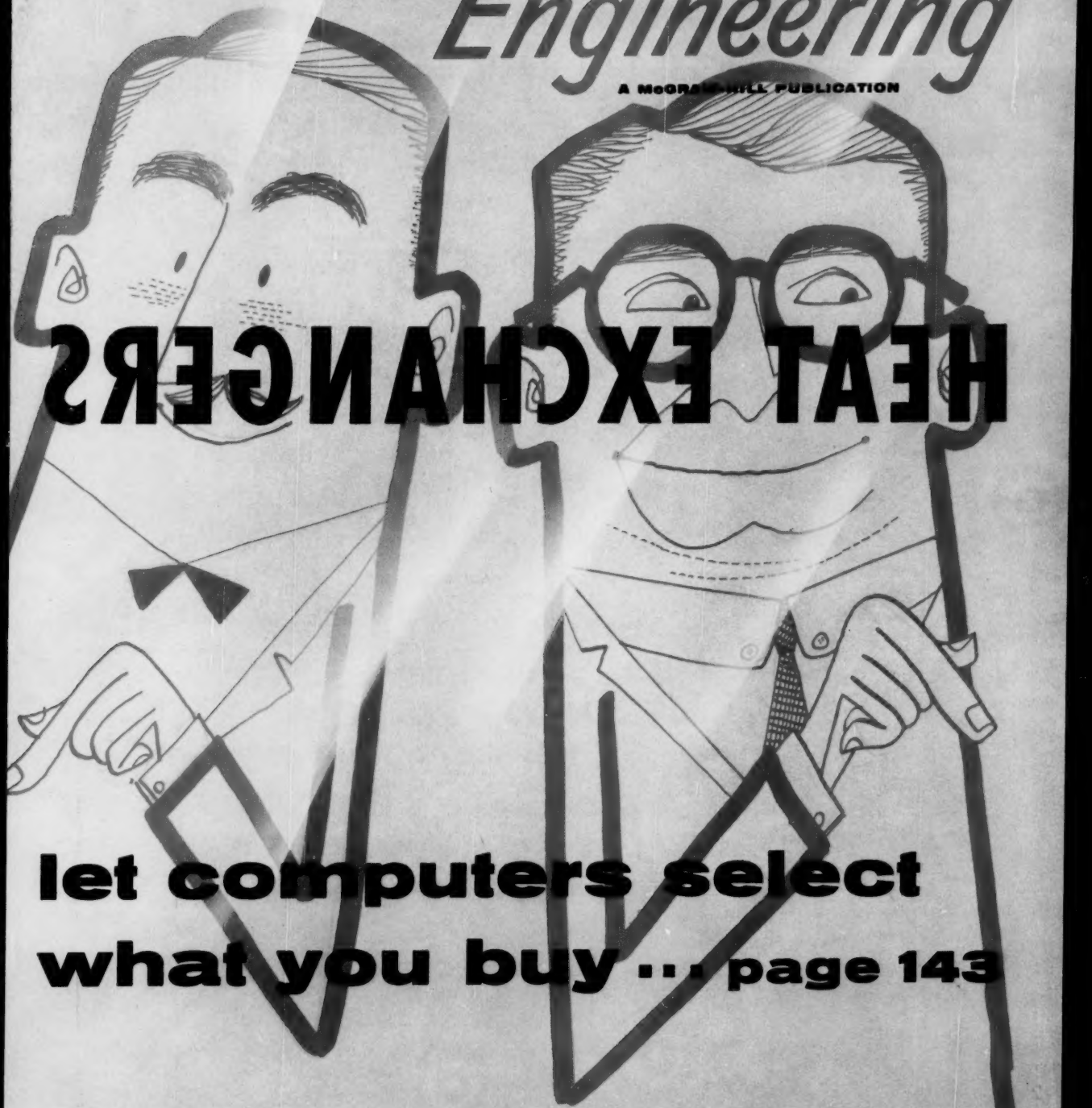
Chemical Engineering

A McGRAW-HILL PUBLICATION



let computers select what you buy ... page 143

LET COMPUTERS PICK YOUR EXCHANGERS
HOW TO ALLOCATE PROCESS STEAM COSTS
WHAT MAKES A SUCCESSFUL ENGINEER

ANNOUNCING THE NEW VOTATOR FILLER

for continuous, high-speed, accurate packaging

New 36-station VOTATOR Piston Type Filler has production rate as high as 1000 per minute. Other models with lower production rates are available.

GIRDLER has acquired all rights for the manufacture and sale of the fast, accurate "Librascope" Fillers. Thus, Girdler applies its 30 years of process industry experience and its precision-production facilities to bring you high standards of packaging economy.

By adding this new line of VOTATOR Fillers to its line of VOTATOR* Heat Transfer Apparatus, Girdler affords many manufacturers a closer integration of processing and packaging operations.

The new VOTATOR Fillers have distinctive improvements for more profitable packaging of many liquid and viscous products. They are fully described in Bulletin PED 257, free on request.

*VOTATOR—Trade-Mark Reg. U.S. Pat. Off.

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Manufacturers of VOTATOR and THERMEX Processing Apparatus

Sales Offices: Louisville, New York, Chicago, Atlanta, San Francisco

MARCH 10, 1958

JOHN R. CALLAHAM, Editor-in-Chief

How to Earn $150,000

"Other things being equal, skill with words will add between $50,000 and $150,000 to an engineer's life-time earnings."

A well-known engineer made this statement several years ago.

You may quarrel with his figures, but I think you'll agree that two of the most important engineering operations carried on today are *talking and writing.*

For no matter what knowledge or what ideas you may have, these will be of little value until you communicate them—and communicate them effectively—to others.

As a chemical engineer, therefore, you must be a salesman (regardless of your job or title) to get people to accept your ideas and to cooperate in the completion of your projects.

Much has been written on how the engineer can learn to write more effectively. Here's one set of rules:

- Think clearly, logically, directly; then write likewise.
- Shed the cliches and pedantries of your profession (and every profession has them).
- Be simple, human, concise—not complex, pompous and verbose.
- Don't pussyfoot: use active verbs and direct statements.
- Give *more* than an even break to short words, short sentences, short paragraphs.
- Try variety and change of pace in your sentences and punctuation.

The business world of tomorrow will certainly put a premium on the man who can save time, others' as well as his own.

So now's the time to sharpen your use of the English language. Put it to work as an effective, time-saving engineering tool.

FIFTH OF TWENTY-SIX ISSUES

5/26

GUIDED TOUR

Why usable solutions to heat exchanger problems are no longer good enough

You don't have to be satisfied any longer with just any usable solution to your problems in heat exchanger selection. Today's computers pick optimum answers to give real investment savings and better performance. Computers save time, they don't make mistakes. Now the best answer can actually cost less. (p. 143)

Where nuclear power will be in 1965

Here are both sides of the ledger on nuclear power. Realistic projections give you the true picture and show what the economic future of such power is really going to be by 1965. (p. 133)

An ugly duckling grows up

Long the "ugly duckling of the pump industry," the vertical volute pump is com-

Chemical

March 10, 1958

GUIDED TOUR

ing into its own. Technological changes—and some expert advice—are behind its increasing acceptance. (p. 139)

Do-it-yourself nomograph

Now you can bypass one batch of messy trial-and-error calculations: Follow these directions to make a nomograph that gives film temperatures of condensers handling noncondensables. (p. 150)

Better way to price process steam

Simplified techniques can now refine the accuracy of your steam cost allocation. These methods let you compare unit costs of steam from boilers, exhaust or extracted steam, and waste-heat boilers. (p. 152)

How to appraise young engineers

Here are the 17 qualities that make for success in chemical engineering. They affect employment, training and growth of young engineers. Look for these qualities and hire with confidence. (p. 171)

CE is edited for the engineer concerned with chemical operations, whatever his function . . . administration, production and plant operations, design and construction, research and development, sales and purchasing. More engineers subscribe to CE than to any other magazine in the field. Print order this issue:

47,532

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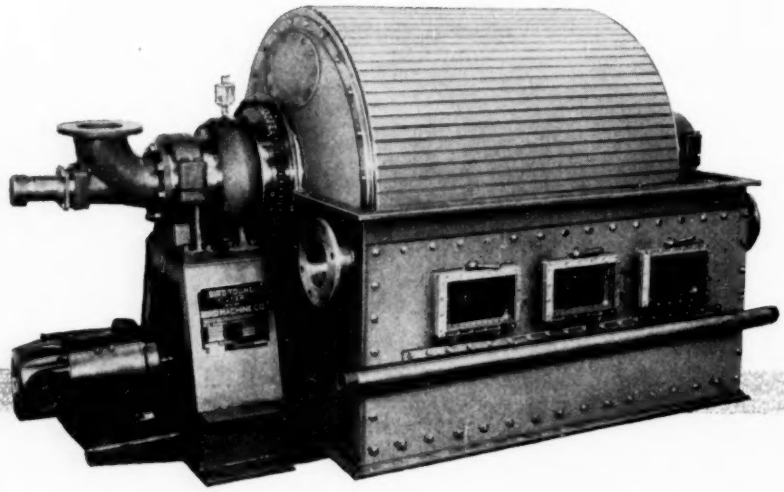
CONTINUOUS VACUUM FILTRATION

Doesn't have to be Expensive and Space-Consuming



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BIRD-YOUNG VACUUM FILTERS

This advanced design of single cell rotary filter offers the following significant advantages:

Highest capacity per foot of filter area — due to complete employment of vacuum directly under the filter medium and to complete elimination of all restrictions to filtrate flow

Effective discharge of very thin cakes — Slow filtering materials can be put through at high drum speed for thorough dewatering and washing plus high output

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Builders of

- Bird Continuous Centrifugal Separators
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This issue's top features of significance in

Petrochemicals & Petroleum Refining

Plastic bags chop barging costs 82

Floating tubular plastic bags, holding 20,000 gal. of fuel oil, that can be towed in line like a sea-going pipeline, may slash barging costs by 60-80%.

New process unit upgrades refinery sludge 88

Pitt-Consol banks on quadrupling output of its aryl mercaptans by grafting a sludge-using unit to its cresylic acid refinery. Price of mercaptans may be cut in half.

Refiners now eye vertical pumps 139

Now gaining more popularity throughout the CPI, vertical volute pumps mean much to oilmen. Refinements eliminate tankcar unloading station and avoid tankcar bottom outlet.

Process calculations often repeat themselves 143

Often you must use the same equations and procedures over and over in tedious heat exchanger calculations. Since only the numbers change, why not hire a computer?

How to find heat of fusion and sublimation 147

In your processing calculations, you'll often have to calculate latent heat of fusion and sublimation. Here are reliable routes that'll save you much time and money.

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There's No Other Welding Tee Like This!

FLOWLINE

TRADE MARK

STAINLESS STEEL, MONEL, NICKEL and ALUMINUM WELDING FITTINGS

Preferred for Dependable Corrosion Service

The Welding Fittings organization — recognizing the superiority of welded piping for corrosion service — was the first to standardize, manufacture, and stock a complete line of stainless steel welding fittings.

The tee shown above—typical of all FLOWLINE Welding Fittings—provides unique features that have been developed through long, intensive specialization in design and production of welding fittings for corrosion service.

FLOWLINE fittings—tees, ells, reducers, stub ends, and caps—are available in sizes ½" through 12", in Schedules 5S, 10S, 40S, and 80S.

Features of FLOWLINE Tees

- Cold formed – seamless – by the exclusive Welding Fittings process.
- Reinforced crotch—tee is stronger than pipe with which it is used.
- Full center to face dimensions.
- Smooth interior walls.
- Ends machine tool cut and finished.
- Annealed, cleaned bright, passivated.
- Heat number permanently stamped on each tee as record of actual analysis and physical properties.
- Every tee is marked with type of metal, size, schedule, wall thickness, and FLOWLINE trade mark.

WELDING FITTINGS CORP.

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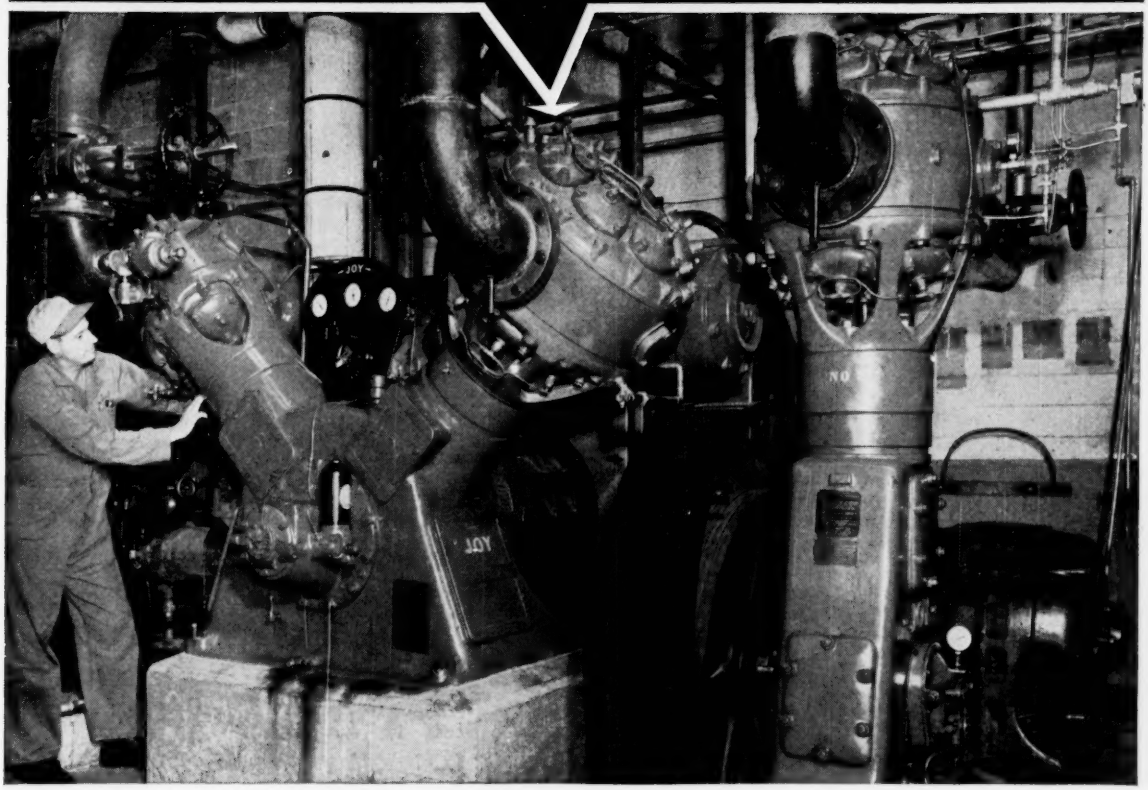
W-10 *World's Largest Manufacturer of Stainless Welding Fittings*

They Needed More Oil-Free Compressed Air But Had Limited Space

A Third Joy Unit Solved it!



A West Coast Company needed more oil-free compressed air . . . in a hurry! However, there just wasn't any space in the boiler room for additional machines. They had been operating two Joy WG-9 OL vertical compressors (the machine at right in the photo). These non-lubricated compressors had run continously . . . 24 hours a day . . . for *17,000 hours with no down time.*

So they again called Joy in on the problem. The solution: One WG-9 OL with 75 hp was taken out and replaced with a Joy WN-112 E-OL rated at 150 hp. This 974 cfm machine supplies plenty of air for the new equipment, yet is compact enough to fit into the small space available.

If you need oil-free air take advantage of Joy's more than 25 years of experience with non-lubricated compressors. Write ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Co. (Canada) Limited, Galt, Ont.*

Write for FREE Bulletin 130-11

Consult a Joy Engineer

For Air and Gas Compressors, Vacuum Pumps and Boosters, Conveyors, Fans, Electrical Connectors.

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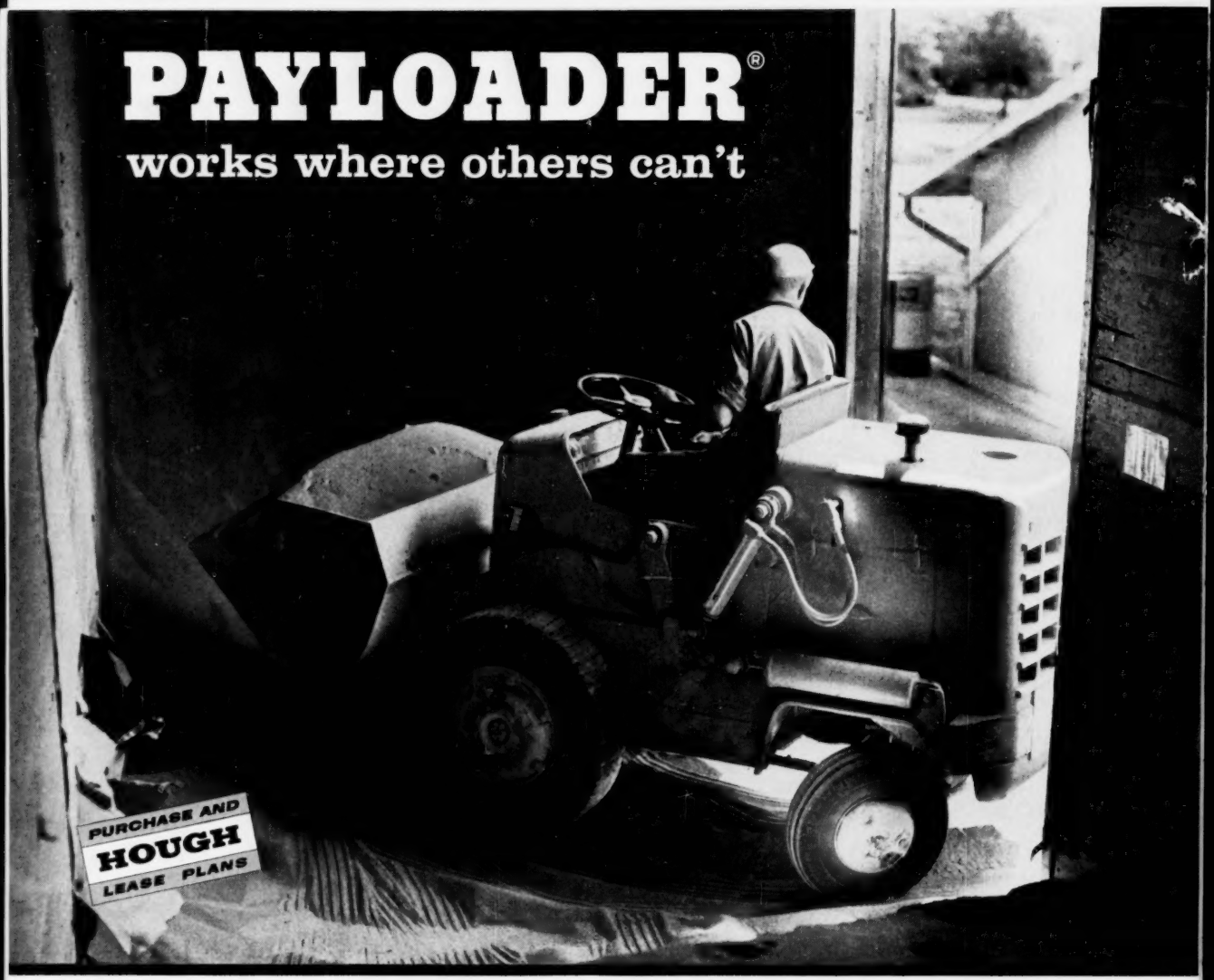
SPECIALISTS IN THE COMPRESSION AND MOVEMENT OF AIR AND GASES SINCE 1885

PAYLOADER®

works where others can't



moves more tonnage because . . .

- ***Shortest turning radius***
- ***Biggest bucket (18 cu. ft. Payload)***
- ***Hydraulic load-shock-absorber***
- ***40° bucket tip-back at ground level***
- ***Exclusive one-lever bucket control***

When you have to unload highest tonnages of fertilizer, chemicals and other bulk materials from boxcars or to move them in other close quarters, you need a model HA "PAYLOADER."

Long-time tractor-shovel users tell us the model HA with its shortest turning radius and one-ton carry capacity is tops in tight quarters—easy and fast to maneuver with or without a load . . . to get full loads quickly, to deliver them safely at speeds up to 10 m.p.h. — thanks to EXCLUSIVE hydraulic load-shock-absorber that smooths the ride and reduces spillage.

For larger capacity, there's the model HAH that carries 1½ tons. Both sizes are available with Scarifier teeth attachment to dig up packed materials from aisles and floors, also pick-up rotary sweeper attachment.

When *you* want the tops in tractor-shovels for fast, low cost bulk-materials handling, contact your "PAYLOADER" Distributor. He has the machines, the experience and the finest of service and parts facilities to keep your tractor-shovel investment profitable.

THE FRANK G. HOUGH CO.
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Accurately measuring liquid density, specific gravity, percent solids or related quantity, the AccuRay Density System applies nuclear radiation measurement to process control. Without contacting the process material, measurement is made continuously, independent of flow rate, pressure or viscosity. The AccuRay System is stable and rugged—designed to withstand shock and vibration under the most adverse industrial conditions.

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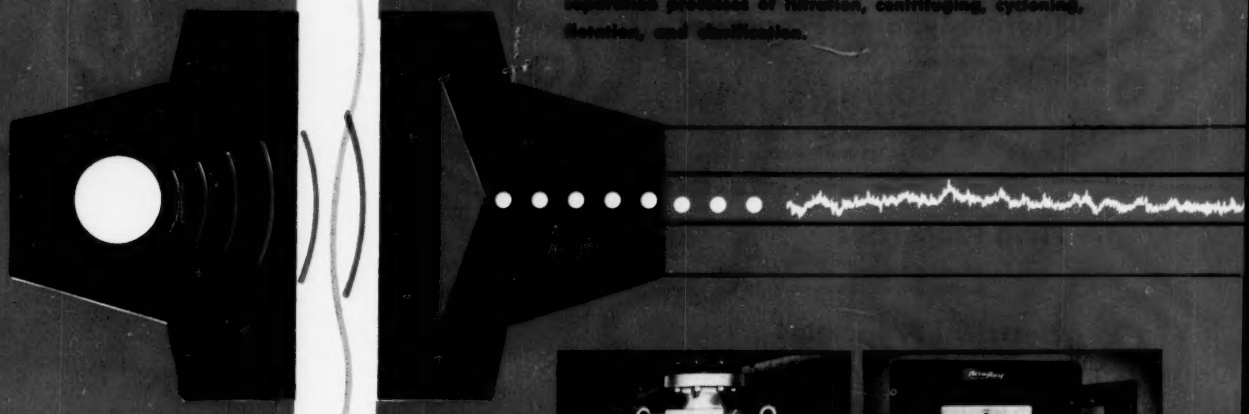
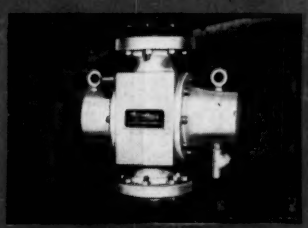
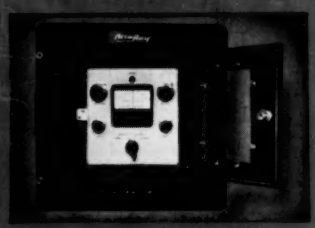




AccuRay Measuring Head is Easily Installed in Pipe System—Flange Connections.



The AccuRay Density Instrument visually indicates variations in fluid density —may be located remotely from measuring head.

® AccuRay is a Registered Trademark of Industrial Nucleonics Corporation

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The World's Largest Manufacturer of Nucleonic Industrial Process Control Systems

QO® TETRAHYDROFURFURYL

COMBINE THESE PHYSICAL PROPERTIES

with a new low price and see the possibilities

General Properties

Molecular weight	102.13
Boiling point (760 mm)°C. (pure)	178
Freezing point, °C.	below-80
Refractive index (n_D)	
at 20°C.	1.4520
at 25°C.	1.4499
Specific gravity	
at 20/20°C.	1.0543
at 24/24°C.	1.0511
at 31/31°C.	1.0450
Flash point, Tagliabue, open cup, °F.	183

Thermodynamic Properties

Heat capacity, cal/g., °C.	
20-27°C.	0.424
30-37°C.	0.432
40-47°C.	0.445
Heat of combustion, cal/g. mole	
at constant volume	708.6
at constant pressure	709.5
Thermal expansion, 20-37.8°C., $\alpha \times 10^{-3}$	0.52

Fluid Properties

Viscosity, absolute, 20°C. centipoises	6.24
Surface tension, dynes/cm at 25°C.	37

Electrical Properties

Dielectric constant, 23°C.	13.6

Other Properties

Octane number	82.5
Solubility: Water, alcohol, ether, acetone, chloroform, benzene	∞
Kauri-Butanol value	71.5
Evaporation rate (n-butyl acetate=100)	7
Dilution ratio (lacquer ingredients)	4.5
Inflammability, air	
upper limit, % by vol.	9.7
lower limit, % by vol.	1.5

The Quaker Oats Company

CHEMICALS DEPARTMENT

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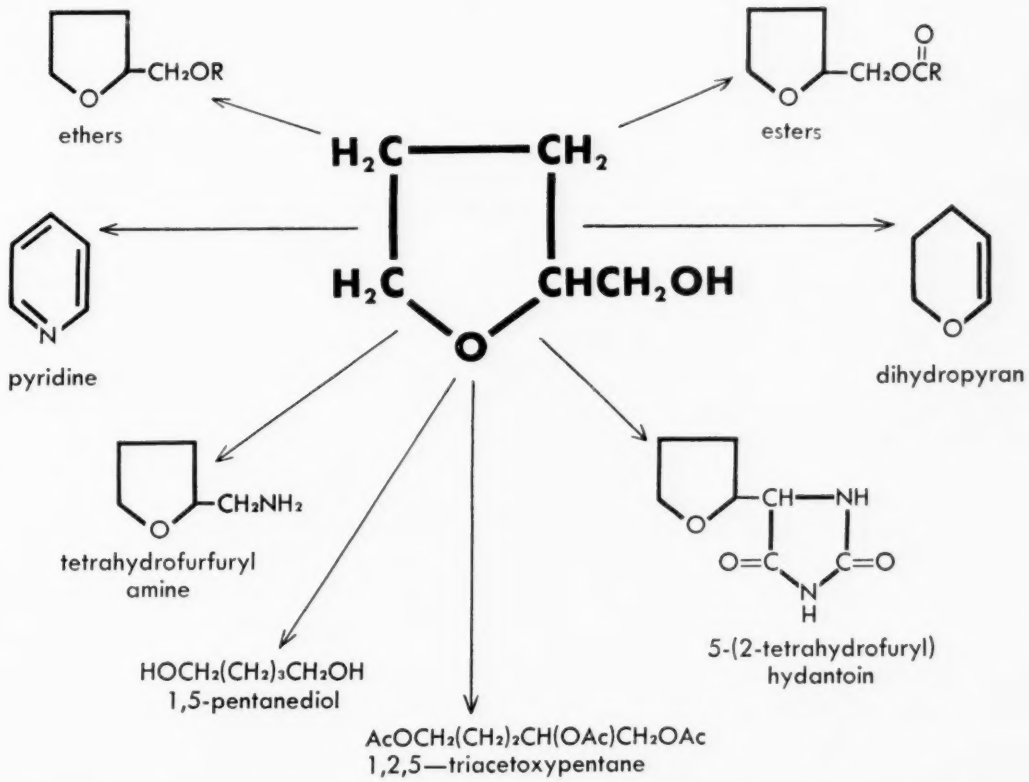

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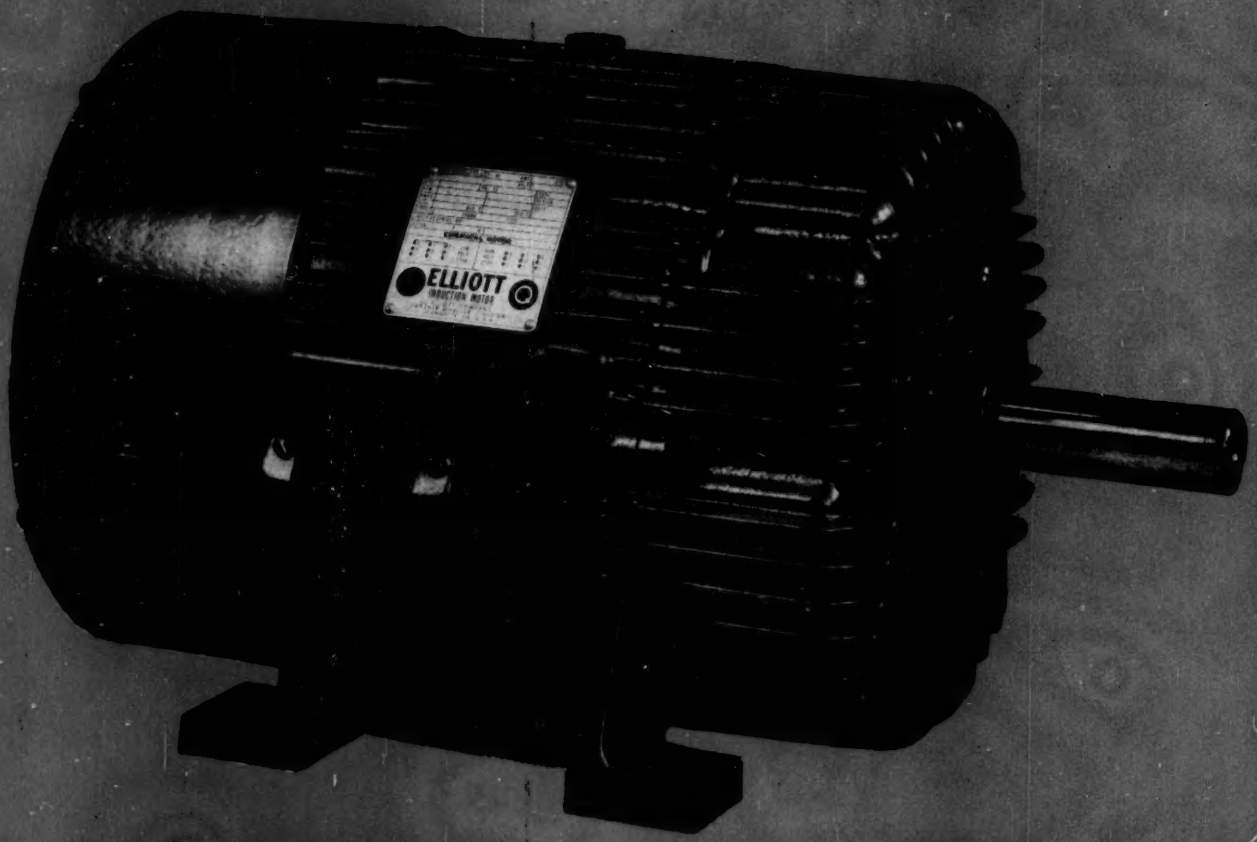
Write for our Bulletin 206 on QO tetrahydrofurfuryl alcohol; it presents chemistry, physical properties and uses of THFA.

Protected



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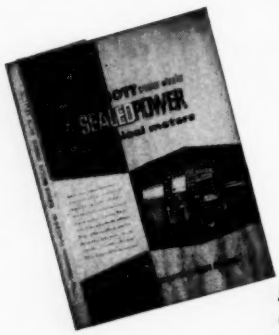


ELLIOTT Company

Crocker-Wheeler Division • **JEANNETTE, PENNSYLVANIA**

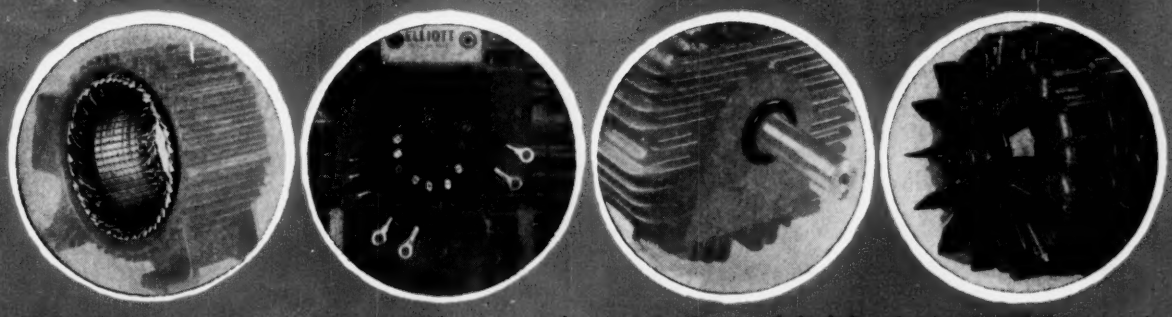
Send for **new bulletin PB 6000-8, describing the remarkable Elliott Sealedpower C-W Chemical Motors.**

against corrosion

new ELLIOTT C-W
sealedpower chemical motor

Thoroughly protected against corrosive vapors, gases and moisture, the new Elliott C-W totally-enclosed Chemical Motors are designed to serve dependably under conditions that would incapacitate other motors. Every vulnerable point has been sealed or armored. The entire frame, fan cowl and conduit box are of corrosion-resistant cast iron. The external fan is made of either cast bronze or cast aluminum (choice depending upon service conditions), with a split hub, keyed to the shaft. The windings are given special chemical-resisting treatment with siliconized varnish, providing a tough surface that resists acids, alkalies and moisture. A rotating slinger on the motor shaft effectively prevents the entrance of moisture and foreign matter. Leads are sealed by tightly-packed grommets. Nameplate is Monel and external hardware is heavily plated.

SOME OF THE PROTECTIVE FEATURES OF ELLIOTT CHEMICAL MOTORS



Windings have special chemical-resisting insulation.

When conduit box is mounted, grommet is tightly compressed, sealing the point where leads pass through the frame.

A rotating slinger guards the shaft opening against the entrance of moisture or foreign matter.

Cast bronze or aluminum external cooling fan is firmly attached to the shaft by both a key and bolted split hub. Safe against loosening and corrosion.

Why even chlorinated compounds do not corrode this pipe

Pump boiling HCl through PYREX brand Pipe *for 200 years* and you'd still find the pipe intact, still trustworthy, still strong, still transparent.

This single fact was enough to convince the engineers at Velsicol Chemical Corporation's Memphis Tennessee plant that PYREX piping is ideal for their chlorinated acids and organics.

It's also a fact that of all the thousands of corrosive chemicals you might pump through PYREX Pipe only hydrofluoric acid and hot alkalies would have any appreciable corrosive effects on the pipe.

Blocks side reactions

No metal traces can enter your process from PYREX Pipe and the glass itself can never act as a catalyst, so you never get contaminating side reactions.

Makes processing *visible*

Transparency is a terrific advantage in piping.

You can *see* the condition of your product and process at all times.

Your maintenance crew saves time with visual inspections, too. Because of its smooth glass surface, PYREX Pipe seldom allows scale or sludge build-up. But should this occur or should something block this pipe, your men can locate the trouble exactly and determine its nature without tearing out the entire pipeline.

New bulletin now out

The new PYREX Pipe bulletin tells you something of the long history of this pipe in chemical processing, examines its many advantages over conventional piping, lists sizes and fittings, and offers information on installation. Send the coupon for a copy.

Corning means research in Glass

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Please send a copy of your **NEW** PYREX Pipe Bulletin.

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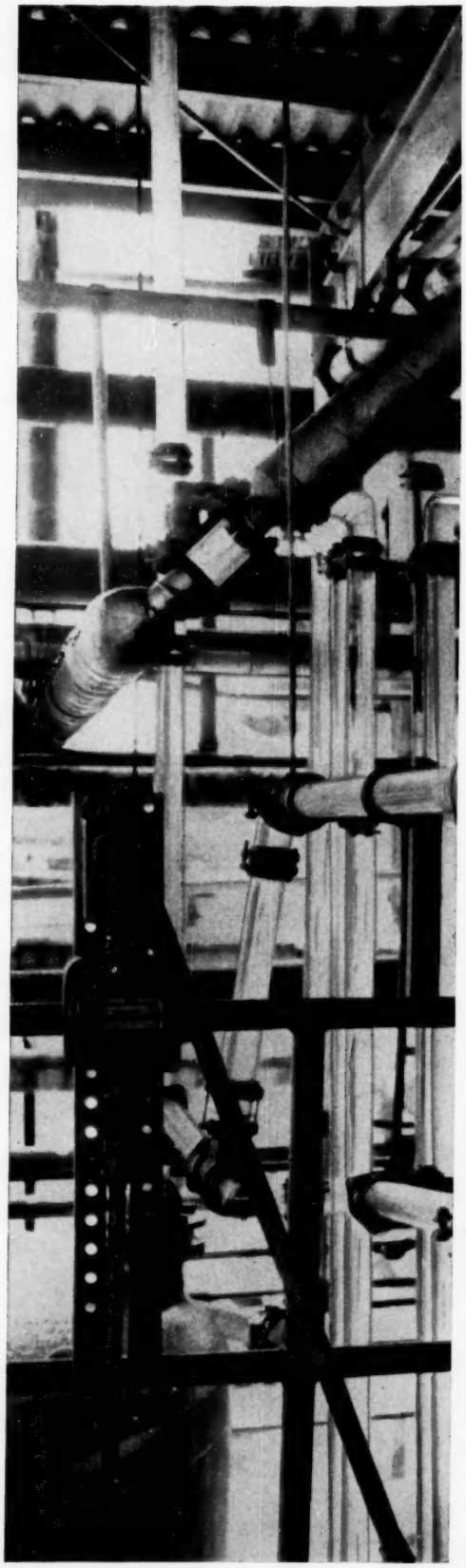
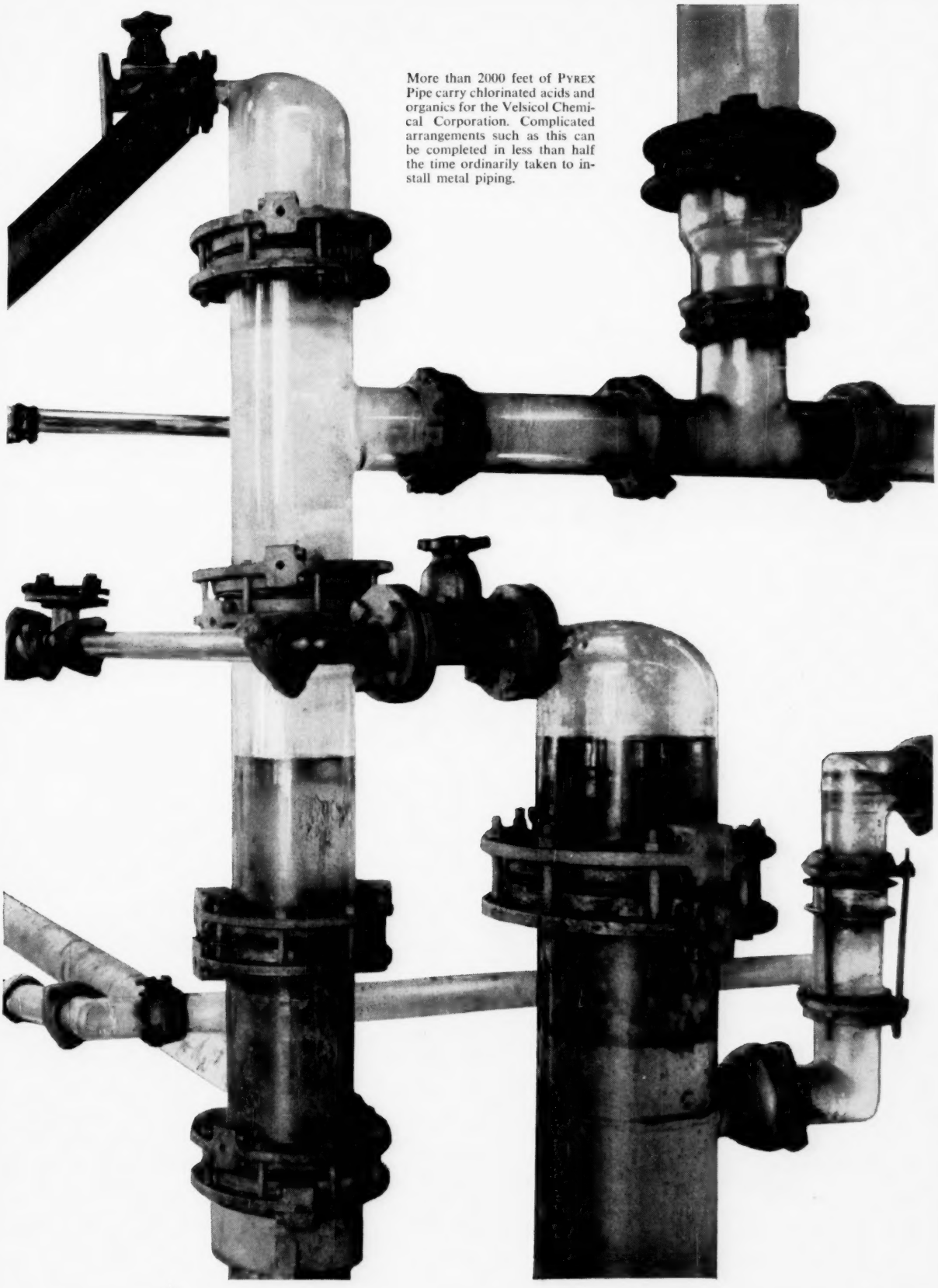
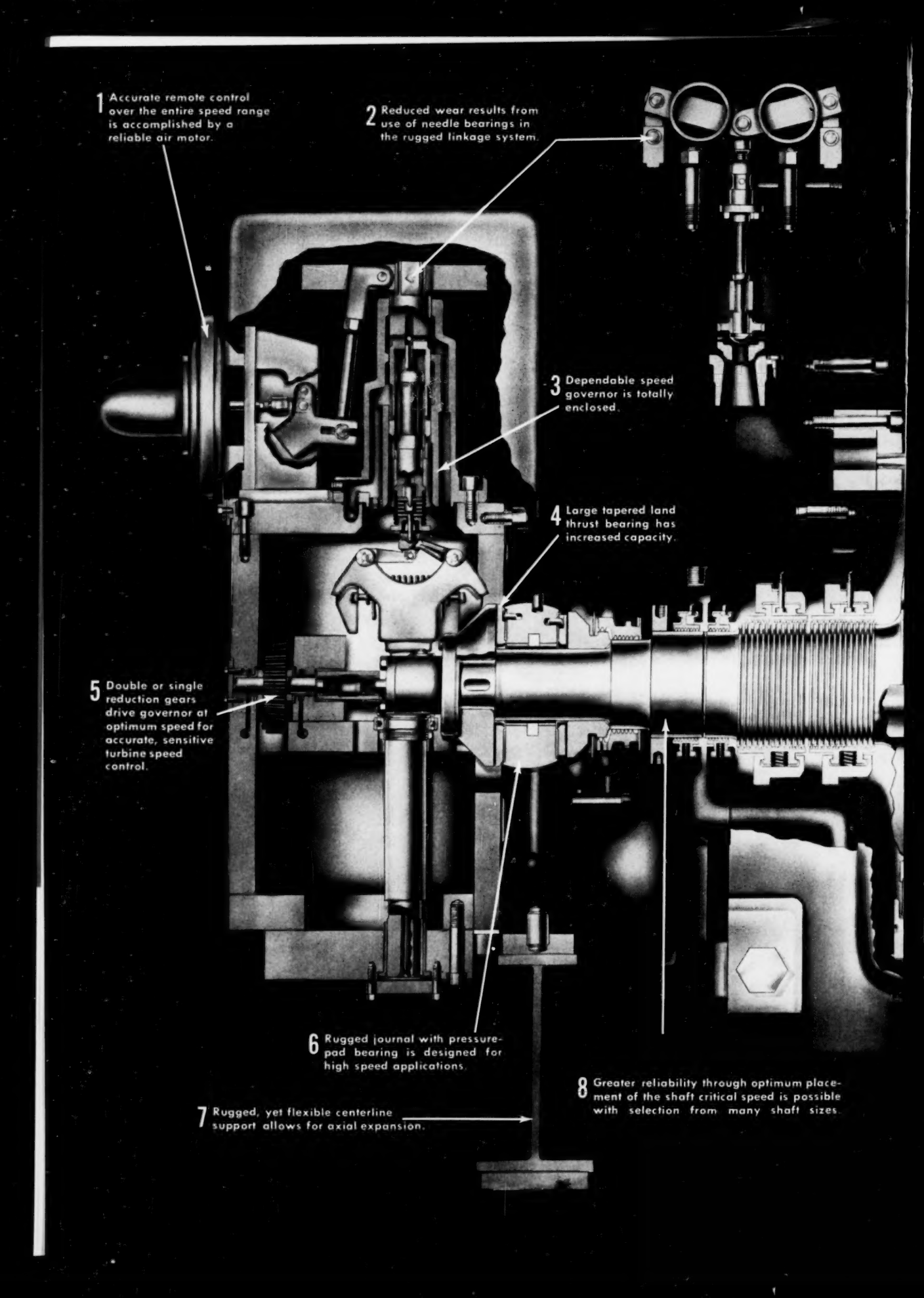
Street.....

City..... Zone..... State.....





More than 2000 feet of PYREX Pipe carry chlorinated acids and organics for the Velsicol Chemical Corporation. Complicated arrangements such as this can be completed in less than half the time ordinarily taken to install metal piping.


1 Accurate remote control over the entire speed range is accomplished by a reliable air motor.
2 Reduced wear results from use of needle bearings in the rugged linkage system.
3 Dependable speed governor is totally enclosed.
4 Large tapered land thrust bearing has increased capacity.
5 Double or single reduction gears drive governor at optimum speed for accurate, sensitive turbine speed control.
6 Rugged journal with pressure-pad bearing is designed for high speed applications.
7 Rugged, yet flexible centerline support allows for axial expansion.
8 Greater reliability through optimum placement of the shaft critical speed is possible with selection from many shaft sizes.

New General Electric turbine front standard helps give

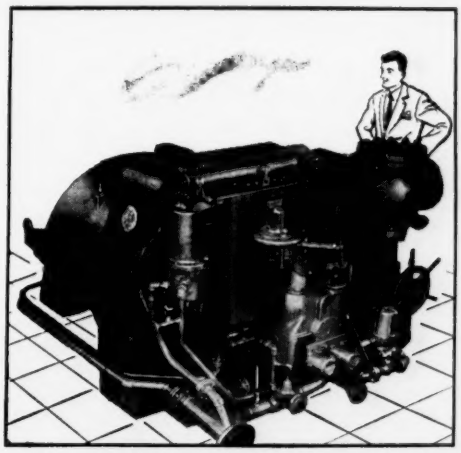
PROFITABLE POWER

by matching process demands for more hp, higher rpm

Now you can drive larger and faster compressors with rugged General Electric mechanical drive turbines. G-E turbine design matches the trend to higher horsepower and speed with a new front standard which allows power in the range of 15,000 hp and speeds up to 12,500 rpm. It can help bring profitable power to your operations.

The new front standard, with its larger selection of shaft diameters and increased thrust bearing and journal capacity, allows optimum placement of shaft critical speeds. This contributes to more reliable operation and longer life at these higher horsepowers and higher speeds.

Find out more about the long term economy of dependable **G-E** mechanical drive turbines. Contact your nearby G-E Apparatus Sales Office, or write to Section 241-10, General Electric Company, Schenectady 5, New York.

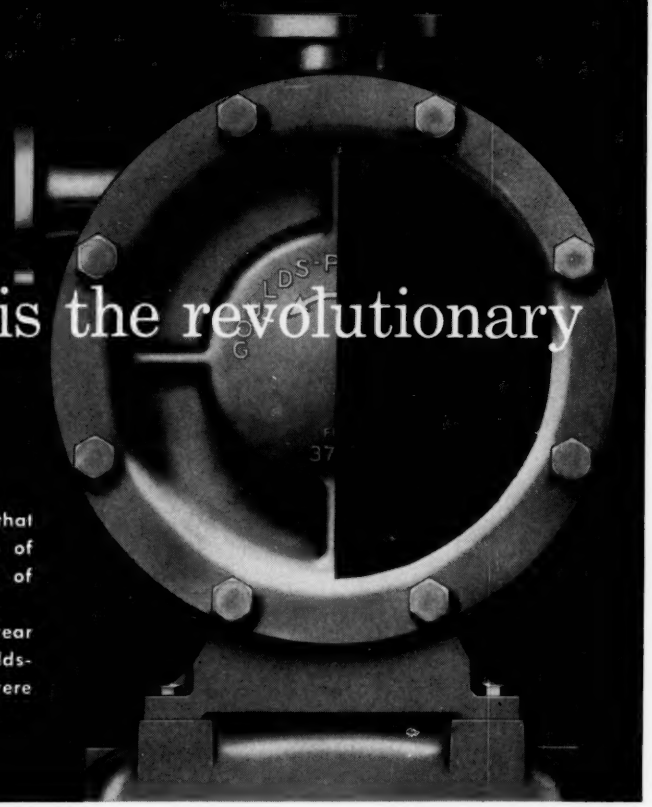


G.E.'S HIGH-SPEED mechanical drive turbine line meets modern process industry demands for higher horsepower and higher speed.

Progress Is Our Most Important Product

GENERAL ELECTRIC

The glass inside this pump is the revolutionary



Here's a unique new centrifugal pump that joins the unexcelled corrosion resistance of Pfaudler glass to the sturdy construction of Goulds pumps.

Scores of installations during the past year have proved the value and economy of Goulds-Pfaudler glassed pumps under the most severe corrosive pumping conditions.

There are 6 important reasons for calling this new pump revolutionary in its usefulness to anyone pumping corrosives.

1. Corrosion resistance. Every pump surface that touches the pumpage is glassed. The borosilicate glass formulated specifically for pump application does not depend upon a passivating film for protection. It therefore offers excellent corrosion resistance to all acids (except hydrofluoric) even at elevated temperatures to 350° F. and to alkalies at moderate temperatures.

This means long service—unmatched freedom from corrosion.

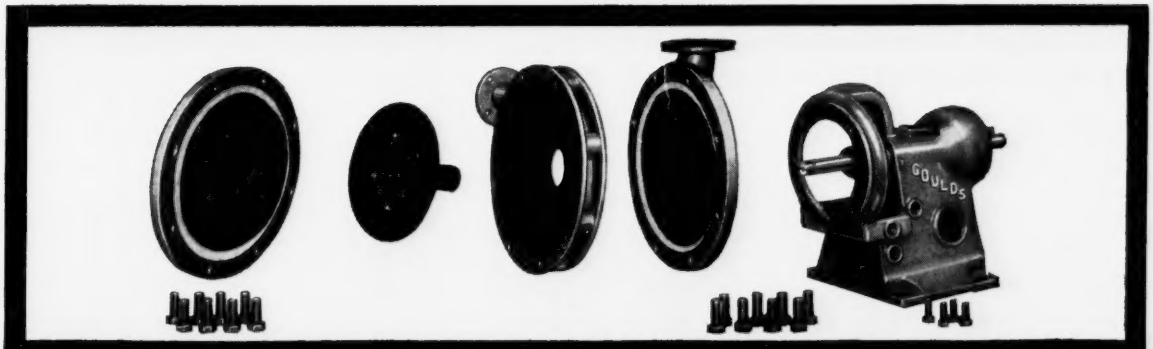
2. Elimination of stuffing box problems. The pump's unusual design places the stuffing box on the suction side of the impeller, subject to low suction pressure only. Inherently, this arrangement insures long packing or seal life and freedom from excessive leakage.

You can get this pump with any mechanical seal arrangement to handle not only clear corrosive liquids, but also abrasive slurries. It is also available with packed stuffing box.

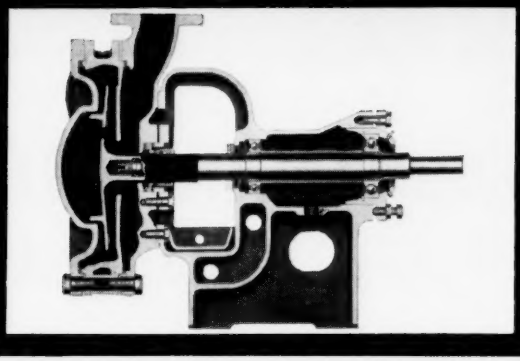
3. Freedom from contamination. Since the glass used in this pump is completely inert, the pumpage cannot "pick up" metallic or other substances which might contaminate or catalyze your reactions. Smoother than the most highly polished metals, the glassed surfaces of the Goulds-Pfaudler pump discourage product adhesion and scale build-up.

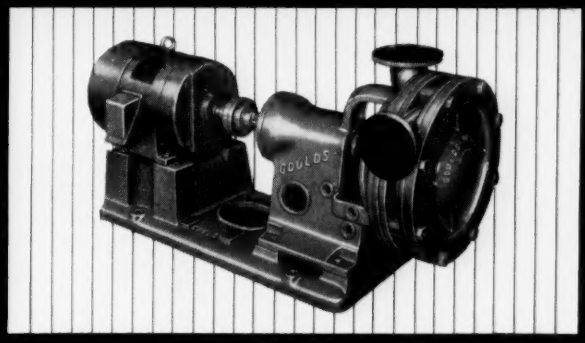
4. Mechanical strength. Goulds-Pfaudler glassed pumps are strong and durable. High temperature firings fuse the special formula glass to the metal chemically and physically, providing a permanent

GOULDS-PFAUDLER
Glassed Pumps



answer to your corrosive pumping problems





glass-to-metal bond.

The resulting combination withstands sudden temperature changes within a range of 100° F. differential —and has the durability you expect from a conventional metal pump—plus remarkable resistance to corrosion.

5. Simple centrifugal design. The glassed pump is conventional in its hydraulic design. There are no special problems of specification, installation, or maintenance. The casing design allows internal inspection, impeller and mechanical seal removal without disturbing piping connections.

6. Economy. The comparatively low cost of glass and the economy of the Goulds-Pfaudler production method combine to make these pumps less expensive than others using special materials and methods to achieve any reasonable measure of resistance to corrosion.

The first cost of a Goulds-Pfaudler glassed pump is likely to be less than you expect. The *total* cost —considering improved pumping efficiency, longer pump life, and uncontaminated process—is almost certain to be lower than any you have known in the past.

Size . . . capacity . . . head. You can choose from four different sizes of the Goulds-Pfaudler glassed pumps, and get capacities up to 700 GPM . . . heads up to 140 ft. The pumps are available for export.

Use the coupon for a bulletin containing complete information, including performance curves.

GOULDS PUMPS, INC., Seneca Falls, N. Y.

Please send me Bulletin 725.2 on the new Goulds-Pfaudler Glassed Pump.

Name..... Title.....

Company.....

Address.....

City..... Zone..... State .....

Heat exchanger photo courtesy The Atlantic Refining Company, Philadelphia, Pa.

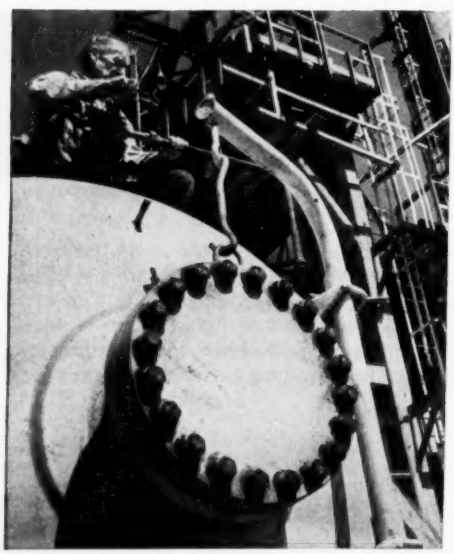
Republic ELECTRUNITE

Gives You a Good,

It's easier, more economical to roll-in Republic ELECTRUNITE® Heat Exchanger Tubing because you get a good, tight seal every time. That's why more and more refineries and processing plants are using Republic ELECTRUNITE for original equipment and for retubing operations.

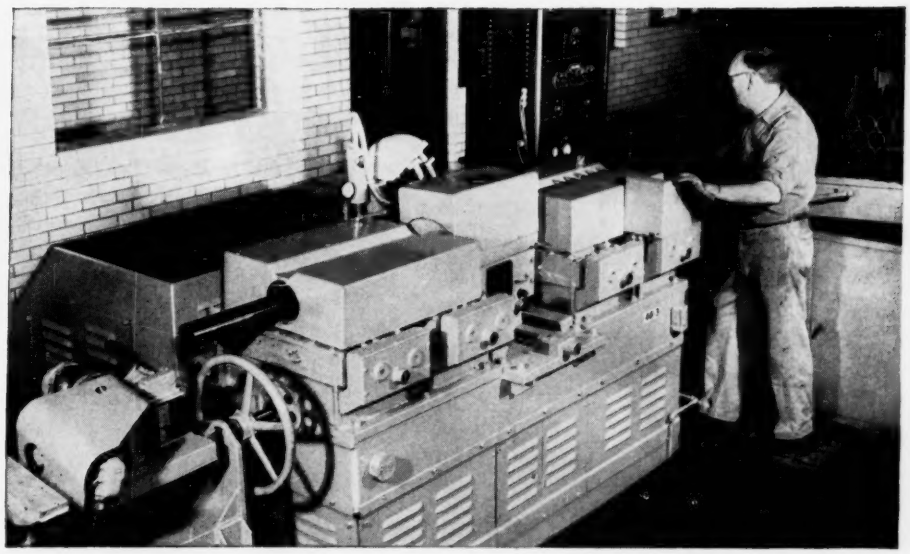
Here's why: Republic ELECTRUNITE provides uniform wall thickness and true concentricity to give the user better control. And it speeds retubing operations, too.

To begin with, ELECTRUNITE Heat Exchanger Tubes are formed from flat-rolled, high quality, open-hearth steel, carefully checked for chemical analysis, physical properties, exact thickness and width, and freedom from scale and surface defects. ELECTRUNITE Tubing is "electrically-welded" with no foreign metal added.



REPUBLIC ALLOY STEEL STUDS AND HIGH CARBON HEX NUTS resist high temperatures, high pressures, corrosion . . . three common causes of stud failure. Clean accurate threads provide maximum holding power, resistance to wear. Specify Republic on your next order.

TRUSCON "BUDGET BUILDINGS" solve housing problems. They are strong, lightweight, flexible. Rigid frame provides unobstructed floor area. Roof and side walls are rust- and fire-resistant galvanized steel—require no painting. Orders filled from "off-the-shelf" stocks of pre-engineered materials. Send for illustrated literature with complete data and facts.



FARROWTEST. Tubes move through a group of test coils. Signal remains constant as long as tube is uniform and free from irregularities. Only Republic offers this "eddy current" type non-destructive test as an alternate to hydrostatic testing, at no extra cost.

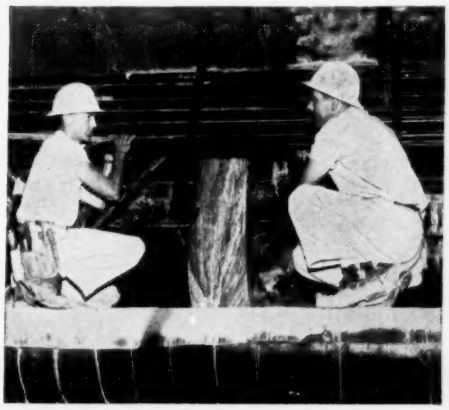
Heat Exchanger Tubing

Tight Seal...Every Time

Each length is normalized above the upper critical limit to relieve stresses; to induce softness; to alter ductility, toughness, electrical, magnetic or other physical properties; to refine the crystalline structure or to produce a definite microstructure. Actually, the carbides go into solid solution and during controlled cooling the carbides disperse evenly throughout the structure.

After straightening, each length is hydrostatically... or FARROWTESTED® (Republic's exclusive non-destructive electronic test) to conform to the applicable code requirements.

If you want to learn more about how you can keep your heat exchanger operations in service at lowest cost, call your nearest Republic representative... or write today.



REPUBLIC "DEKORON®-COATED" E.M.T. saves costs of electrical raceway maintenance under severe corrosive conditions. Tough, polyethylene coating over galvanized finish gives double protection to electrical raceways. See your electrical supplier or contractor.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. CE -5310
1441 REPUBLIC BLDG. • CLEVELAND 1, OHIO

Please send me additional information:

☐ ELECTRUNITE Heat Exchanger Tubes ☐ FARROWTEST
☐ Alloy Studs and Hex Nuts ☐ "Dekoron-Coated" E.M.T.

Name _____ Title _____

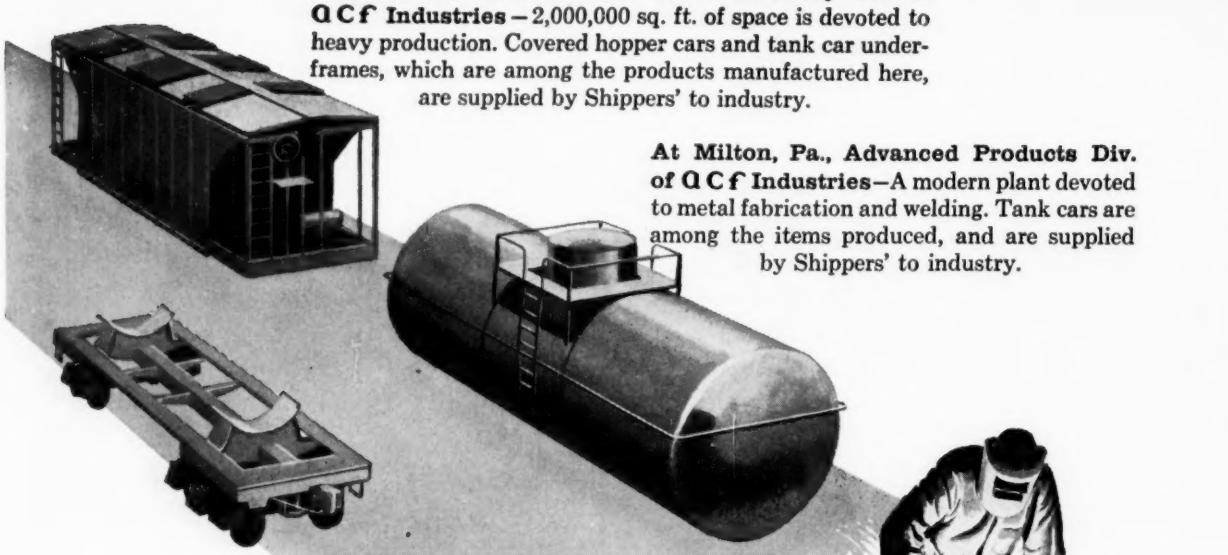
Firm _____

Address _____

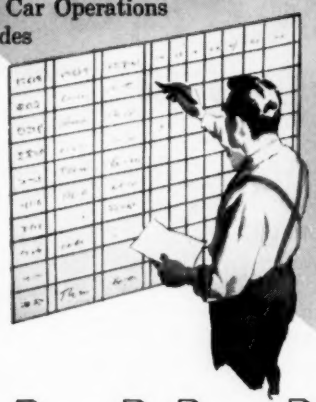
City _____ Zone _____ State _____

At Berwick, Pa., American Car & Foundry Div. of ACF Industries—2,000,000 sq. ft. of space is devoted to heavy production. Covered hopper cars and tank car underframes, which are among the products manufactured here, are supplied by Shippers' to industry.

At Milton, Pa., Advanced Products Div. of ACF Industries—A modern plant devoted to metal fabrication and welding. Tank cars are among the items produced, and are supplied by Shippers' to industry.



At New York, N. Y.—An efficient Car Operations Section maintains records and provides pertinent information on car movements to lessees.



Car Repair Plants—Five repair plants spread throughout the United States are staffed by trained men backed by the experience of the Car Repair Engineering staff at New York.

What's behind the man

SHIPPERS' CAR LINE

DIVISION OF ACF INDUSTRIES

INCORPORATED

30 CHURCH STREET, NEW YORK 7, N. Y.

CHICAGO, ILL. • HOUSTON, TEX. • SAN FRANCISCO, CAL. • MILTON, PA. • EAST ST. LOUIS, ILL. • CLEVELAND, OHIO • SMACKOVER, ARK. • TULSA, OKLA. • NORTH KANSAS CITY, MO. • REDHOUSE, W. VA.

SHIPPERS
SHPX
CAR LINE

The full facilities of ACF Industries stand behind the man from Shippers'! The engineering and production "know how" which over the years has made ACF a standard for quality is available to industry in the tank cars and covered hoppers leased and sold by Shippers'.

Modern strategically located repair shops keep the leased equipment in excellent condition. Here as always, the ACF standard of quality and service is rigidly maintained. The prompt availability of car parts completes the picture of extras available to Shippers' customers.

ACF-DURADOME Tank Cars — modern way to safely ship all types of bulk liquids.

ACF-Covered Hopper Cars prevent costly contamination, reduce handling costs.

Parts — A full complement of parts may be purchased through the Shippers' offices. This is facilitated by the newest parts catalog in the industry containing over 2,000 items.

Sales — Shippers' six Sales Offices are staffed by men eager to help and able to draw upon the total resources of ACF Industries in providing service.

from Shippers'

HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 6 OF A SERIES)

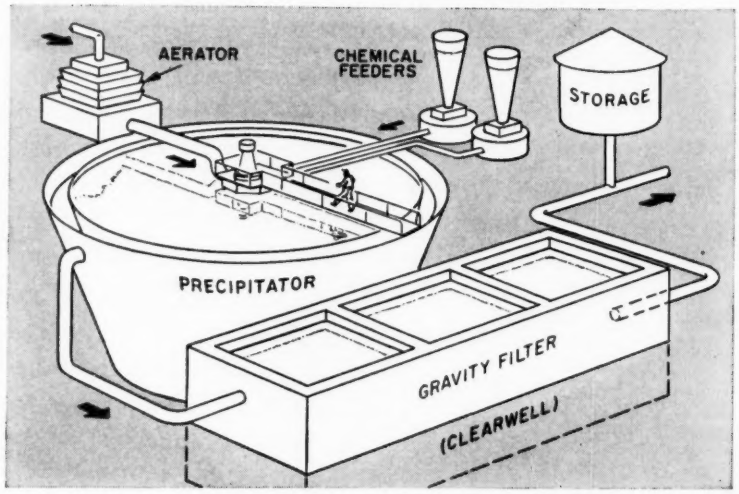
Typical Water-treatment Systems

These factors are involved in selecting types and sizes of equipment for a specific use: Analysis of the raw water, volume and quality of water required, initial and operating cost of equipment, rate of amortization and future expansion possibilities. Typical systems illustrating widely varying requirements:

Treating a well water for a municipal water supply

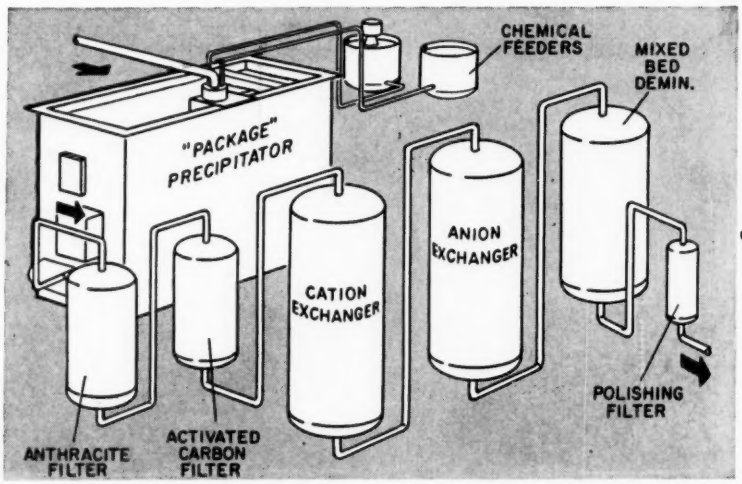
(or as pretreatment for demineralizing)

Aerator reduces CO_2 . . . to lower acidity. It also reduces taste and odor and oxidizes any dissolved iron or manganese. **Precipitator,** depending on the chemicals used, removes turbidity, color, hardness and oxidized iron and manganese. **Gravity filter** removes remaining traces of turbidity from Precipitator effluent.



Treating a process water used in manufacturing electronic components

"Package" Precipitator removes the bulk of the turbidity, hardness and iron. **Anthracite filter** removes remaining suspended matter from precipitator effluent. **Activated carbon filter** removes color and absorbs dissolved organic matter. **Demineralizer** (cation, anion and mixed-bed units) reduces dissolved solids to a very low, guaranteed maximum. **Polishing filter** removes traces of suspended matter from demineralizer effluent.



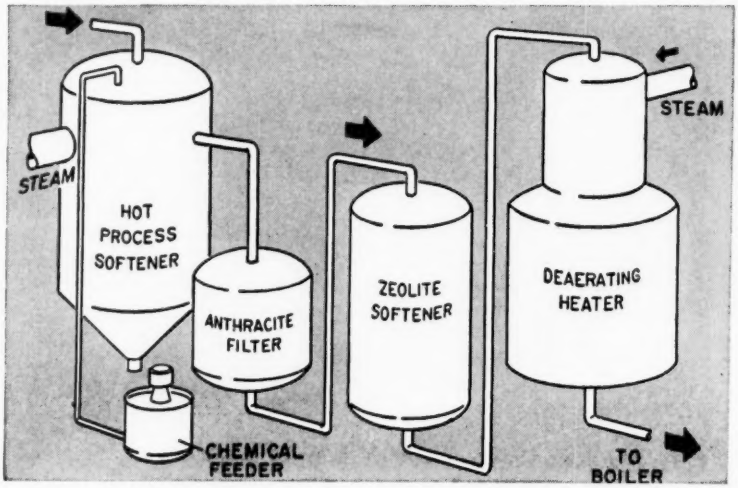
NOTE: Reprints of this series of advertisements, "How to Select Water-Conditioning Equipment," are recommended as a handy "short course" for students and engineers. A set of reprints will be sent free, on request.

Treating water for a steam boiler

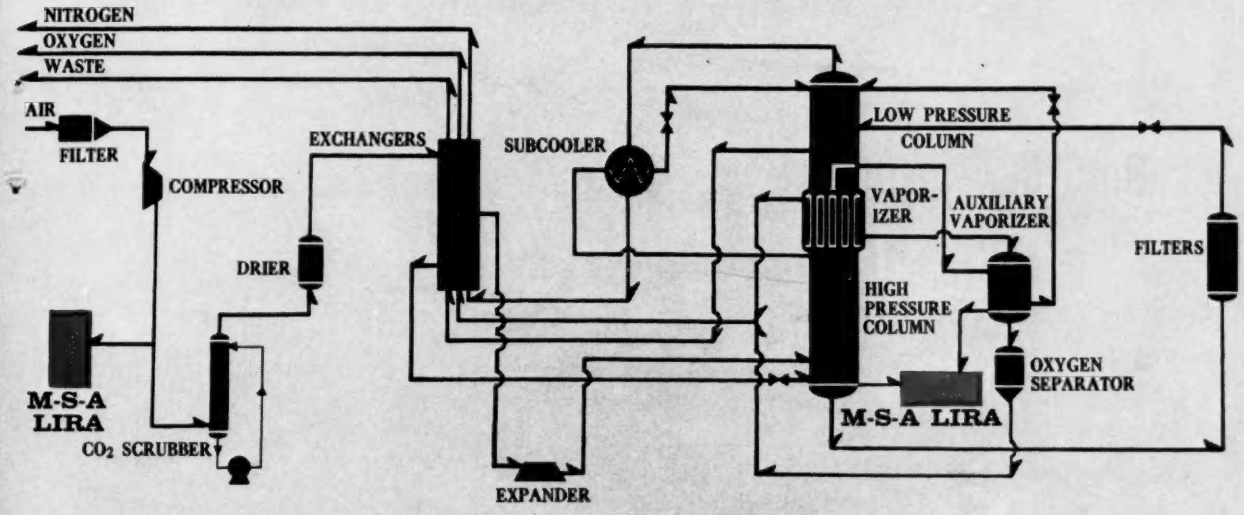
(For high-pressure-boiler feedwater treatment, see "9 ways to demineralize water by ion exchange".)

Hot-process softener reduces hardness to a few grains per gallon. It also reduces silica. **Anthracite filter** removes remaining turbidity from the effluent of the hot-process softener. **Zeolite softener** may be added where zero hardness is required. **Deaerating heater** removes oxygen to prevent corrosion.

For general recommendations on any type of water problem or equipment for its correction, write The Permutit Company, Dept. CE-3, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.



PERMUTIT®
rhymes with "compute it"
a division of PFAUDLER PERMUTIT INC.
Water Conditioning
Ion Exchange • Industrial Waste Treatment



Flow diagram of a standard medium pressure air separation cycle employing M-S-A LIRA Analyzers for plant safety.

M-S-A® LIRA Analyzers can protect your oxygen plant

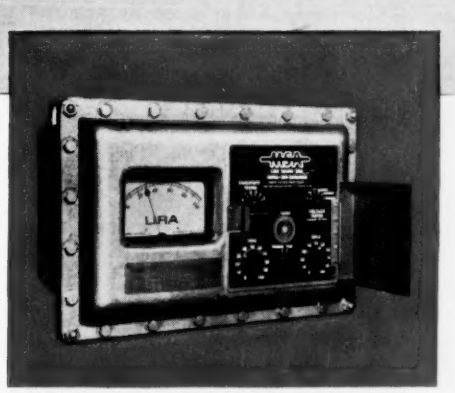
You can keep strict tabs on dangerous accumulations of acetylene and total hydrocarbons by continuously monitoring the air stream and the liquid pool with M-S-A LIRA Infra-Red Analyzers

Safe operation of air separation equipment demands continuous monitoring of acetylene. This troublesome hydrocarbon contaminant has very low solubility and is highly reactive. That's why a number of plants throughout the country are installing M-S-A LIRA Infra-Red Analyzers for explosion prevention.

These versatile instruments measure acetylene and total hydrocarbons in the air intake streams, as well as in the liquid pool itself. Model 100 LIRA Analyzers have been sensitized for full scale ranges of 1.0 and 2.0 ppm acetylene. Thus, it is possible to measure concentrations as low as 0.02 ppm acetylene. With this sensitivity it is also possible to continuously monitor the air stream and sound an alarm in the event a large concentration is suddenly drawn into the plant or, if there is a gradual build-up.

Model 200 Analyzers have been provided to measure the total hydrocarbons present in the air stream as well as the liquid oxygen pool. By means of these instruments, operators are advised at all times of the degree of contamination in the system, and can take steps to prevent development of explosive mixtures.

An M-S-A Instrument Specialist will be happy to discuss your product contamination problems. Write us for helpful literature.

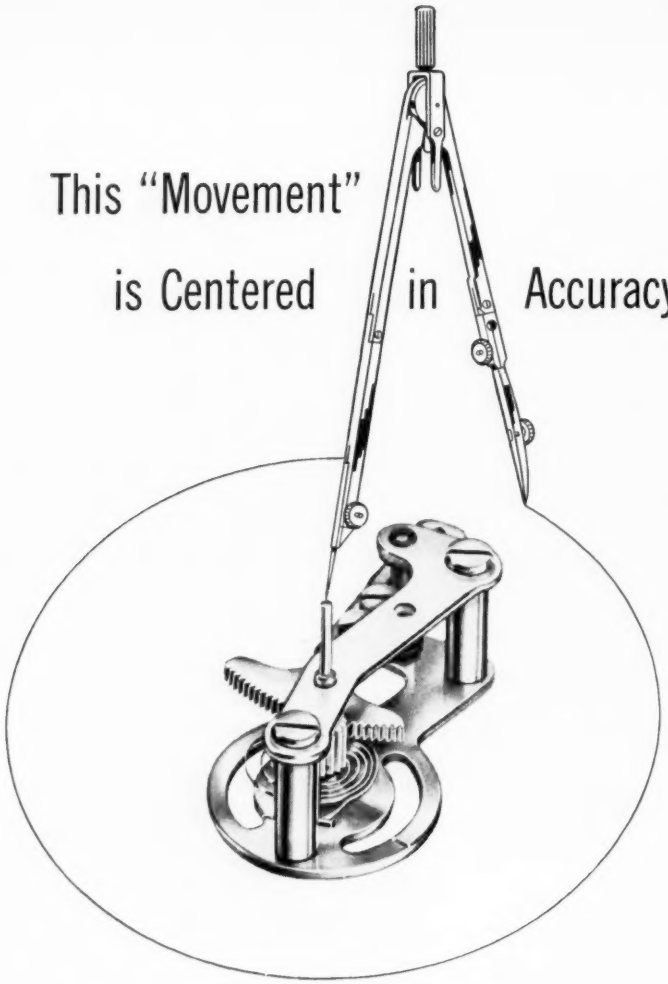


Explosion-proof Model 200 has a tamper-proof lock, and all controls are easily accessible through the explosion-proof enclosure.

INSTRUMENT DIVISION

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

This "Movement" is Centered in Accuracy



The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

Correct calibration is guaranteed: the one-piece link between movement and Bourdon tube prevents slippage or parting under tension. Recalibration is easy from front or rear. Universal adjustability permits uniformly graduated dials.

You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

Ashcroft Duragauge in Alumalife® case—a lifetime case made of special aluminum alloy.

MAXWELL MANNING & MOORE INC. M&M TRADE MARK

G1-58

ASHCROFT PRESSURE GAUGES

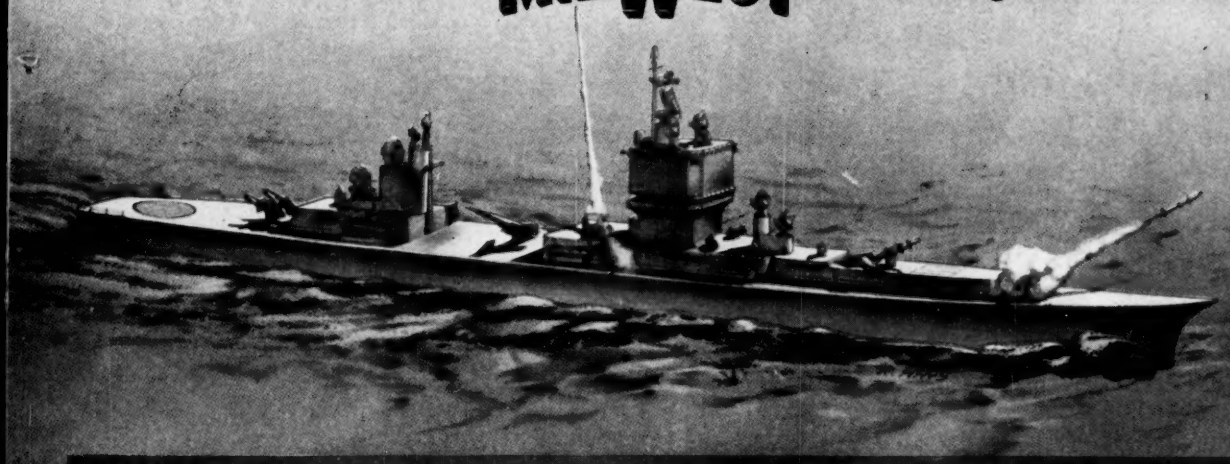
A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

World's First Nuclear-Powered Surface Ship will have MIDWEST Welding Elbows

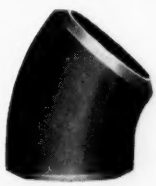


U. S. Navy's guided missile, nuclear-powered cruiser "Long Beach"

OFFICIAL U. S. NAVY PHOTOGRAPH

Special Fittings are "ROUTINE" for Midwest

Stainless Steel
S.R. 102° Elbow
with tangent on one end.



Stainless Clad
S.R. 39° Elbow
with tangent on one end.

Stainless Steel
S.R. 90° Elbow
with tangent on both ends.

Special Elbows (dimensions, tangents, wall thicknesses and materials) are easily provided by the exclusive and flexible Midwest method. Elbows are available in any material that can be secured as plate, which also means better delivery. Closer tolerances are inherent in the Midwest process. Quality control always exceeds Code requirements.

Shown here are three of the special stainless steel and stainless-clad elbows made by Midwest for the "U.S.S. Long Beach". All reactor coolant piping must meet extremely rigid specifications because of the difficult service. Special quality controls, such as ultrasonic testing, intergranular corrosion tests, dye checking, radiography, and ring flattening tests were used one or more times at various stages of manufacture from the raw material to the finished fittings. Special quality standards for soundness of metal, "water clear" welds, dimensional accuracy, and surface finish were satisfied.

The U. S. Navy's first nuclear-powered surface ship, the "Long Beach", will introduce a radically new concept in defense capabilities. She will operate offensively and independently of other forces under conditions of both nuclear and non-nuclear warfare against airborne, surface or under-sea opposition. In addition to equipment and weapons for detecting and destroying enemy submarines, she will carry the Navy's modern guided missiles.

The piping for the atomic reactors being designed and developed by the Westinghouse Electric Corporation will use a large number of special heavy wall stainless steel Midwest Welding Elbows. This is not the first atomic project for which Midwest Welding Fittings have been used. In fact, when the nuclear propulsion program first began, Midwest furnished special welding fittings for the "Nautilus" prototype installation at Arco, Idaho.

Whether or not you are concerned with nuclear power, Midwest Welding Fittings (both stock and specials) will do a better job for you. Ask your Midwest distributor or write us for Catalog 54, which tells you why.

MIDWEST PIPING COMPANY, INC.

Main Office: St. Louis 3, Missouri (P.O. Box 433)

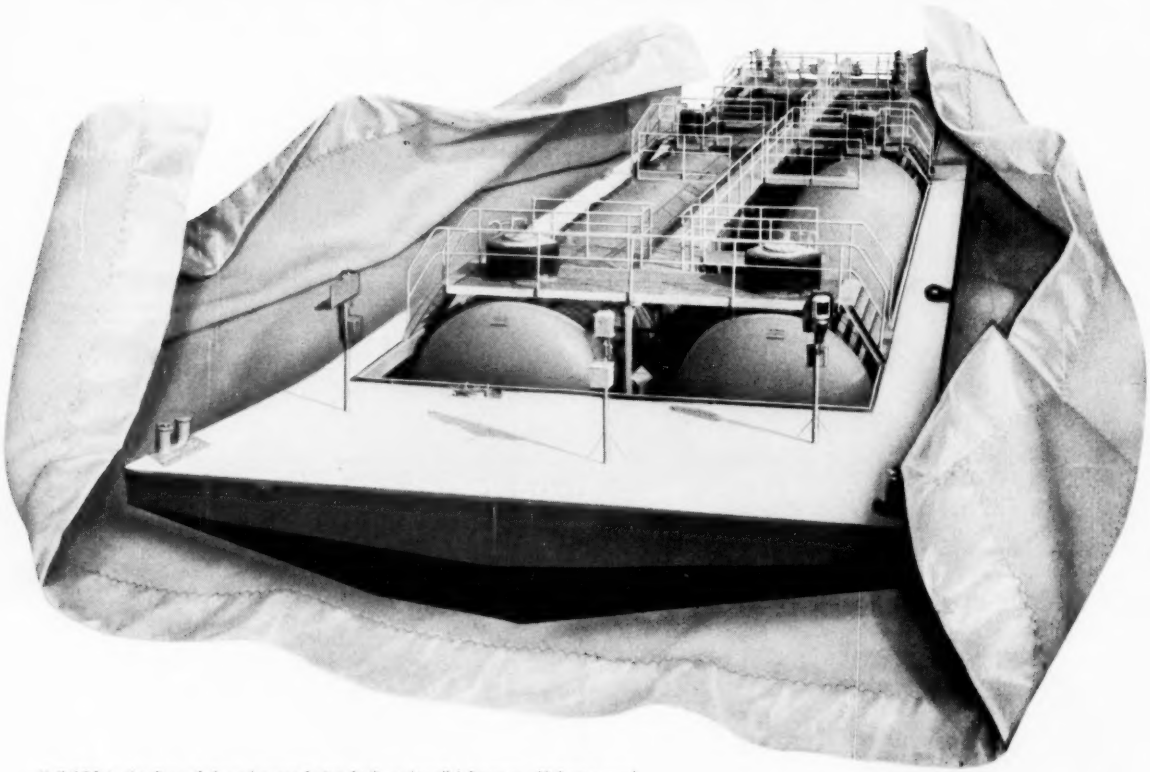
Plants: St. Louis, Clifton, N. J. and Los Angeles

SALES OFFICES: ASHEVILLE (BOX 446, SKYLAND, N.C.) • BOSTON 27—426 FIRST ST.
CHICAGO 3—79 WEST MONROE ST. • CLEVELAND 14—616 ST. CLAIR AVE.
HOUSTON 2—1213 CAPITOL AVE. • LOS ANGELES 33—520 ANDERSON ST.
MIAMI 34—2103 LE JEUNE RD. • NEW YORK 7—50 CHURCH ST.
PITTSBURGH 19, PA.—437 GRANT ST. • ST. LOUIS 4—1450 S. SECOND ST.
SAN FRANCISCO 11—420 MARKET ST.
STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

7918

MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

INGALLS wraps an insulating blanket around 1200 tons of caustic soda!



Hull 992 is the first of three barges being built at Ingalls' Decatur, Alabama yard for Westvaco Chlor-Alkali Division of Food Machinery and Chemical Corporation.

Transportation of caustic soda (NaOH) in any quantity is a ticklish task... and hauling 200,000 gallons of it posed a real challenge!

By combining its engineering skills and complete steel fabrication facilities in the construction of *Hull 992*, INGALLS again demonstrated its ability to solve the intricate problems involved in hauling heavy chemicals.

Each 195′ barge will carry two tanks, having 200,000 gallon capacity, fabricated by the Birmingham Tank Company, an INGALLS' division. To prevent the cargo from freezing, tanks have built-in steam heating coils and are insulated with four inches of foam glass and rubber-lined to prevent corrosion. Motor-driven pumps are provided for discharging cargo. Tanks can also be emptied by pressurization as they are built to take 50 lb. pressure per square inch. INGALLS' improved bow design on the hulls will reduce towing resistance.

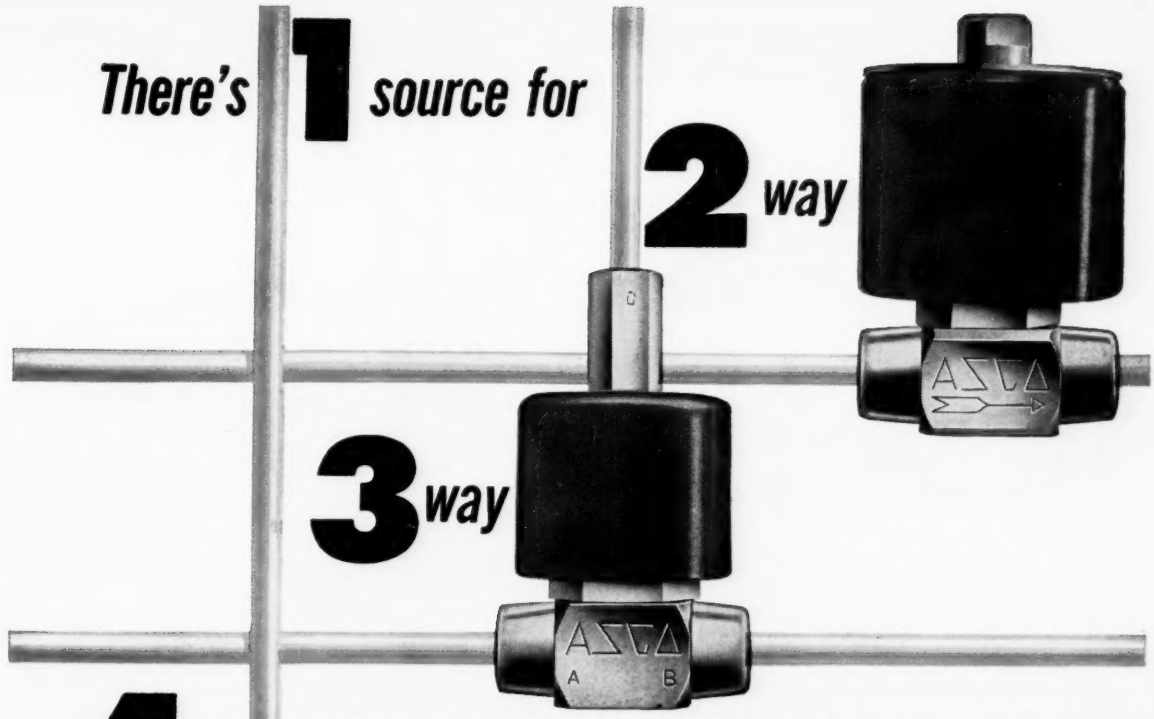
This is just one more example of INGALLS' ability to solve almost any problem involving marine transportation. INGALLS' engineering experience and complete fabrication facilities are at your service for construction or repair at either one of the two yards listed below.

THE INGALLS SHIPBUILDING CORPORATION

Executive Offices: Birmingham, Alabama

Shipyards: Pascagoula, Mississippi (Two yards on the Gulf); Decatur, Alabama (Largest yard on the Tennessee River)

There's 1 source for 2 way 3 way or 4 way MIDGET SOLENOID VALVES

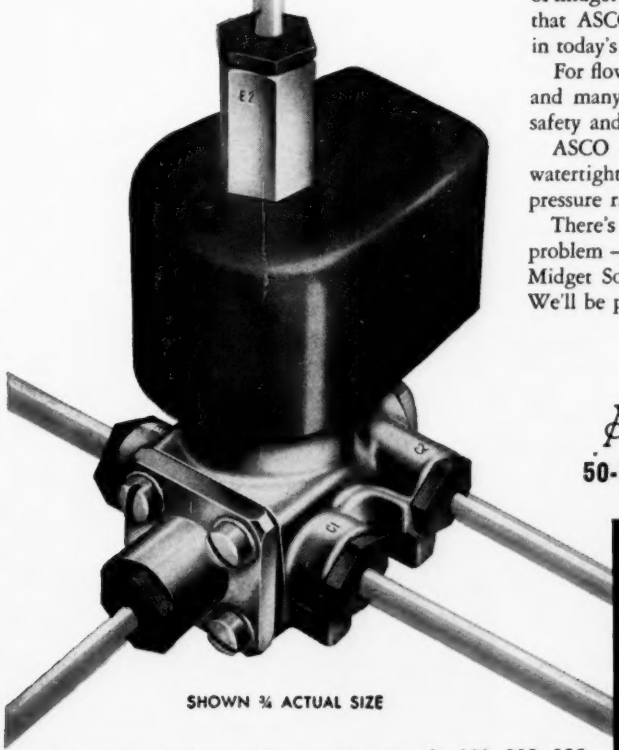


Progressive designers, the men who lead the trend toward miniaturization, depend on ASCO as the one source for a full line of midget solenoid valves. The unexcelled quality and dependability that ASCO pioneered in the solenoid valve field is found, too, in today's midget solenoid valves. Only the size has been reduced.

For flow applications using air, gas, water, light oil, refrigerants and many other liquids, ASCO Midget Valves assure complete safety and truly exceptional performance.

ASCO Midget Solenoid Valves are available with standard, watertight or explosion-proof enclosures. Pipe sizes ⅛" and ¼"; pressure range 0-1000 psi.

There's *one* source that solves virtually any solenoid valve problem – ASCO. Write today for complete data on ASCO Midget Solenoid Valves – or outline any of your requirements. We'll be pleased to assist you.



SHOWN ¾ ACTUAL SIZE

AUTOMATIC TRANSFER SWITCHES
SOLENOID VALVES ELECTROMAGNETIC CONTROL

Automatic Switch Co.
50-D Hanover Road, Florham Park, New Jersey
FRontier 7-4600

ASCO®

Visit Us at the Design Engineering Show Booths 381, 383, 385

Newly designed
Type H Motor Control

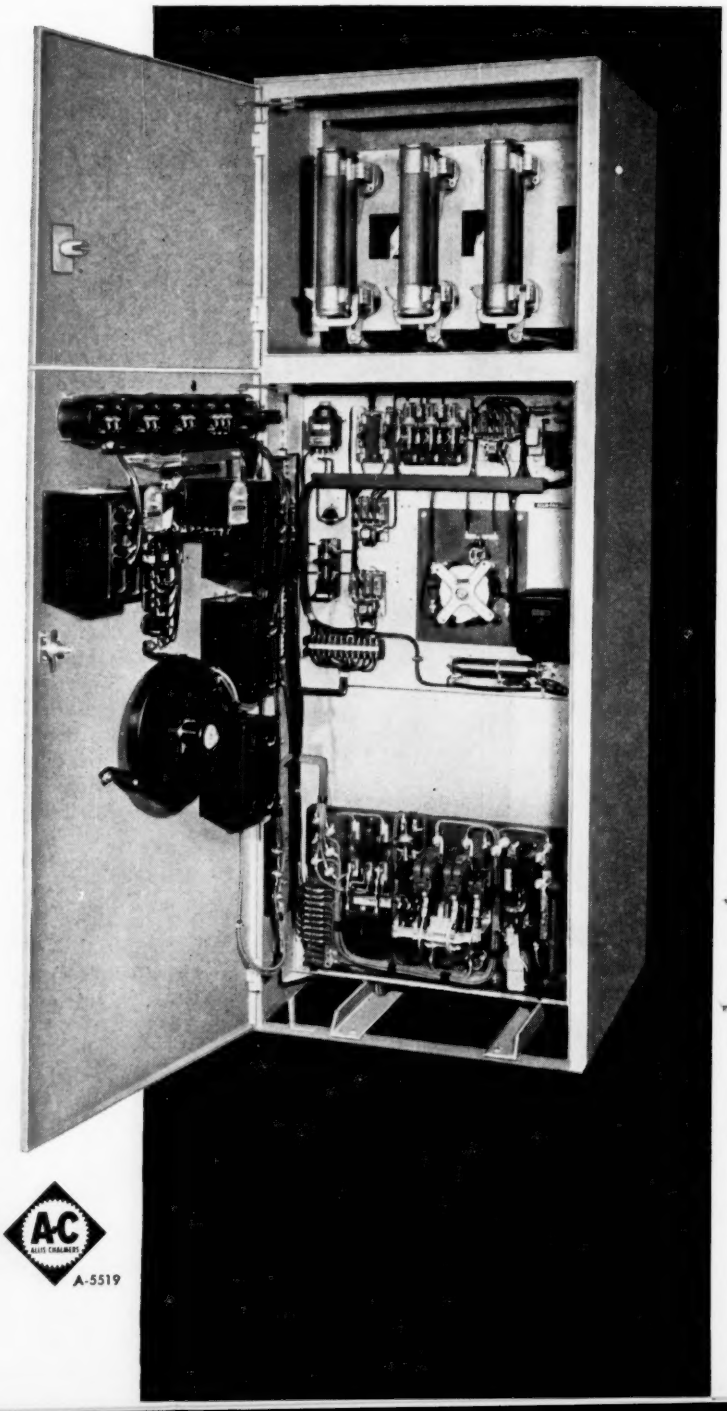
More room for optional features

Now, with Allis-Chalmers high voltage control, you get more panel space for additional components.

Meters, pushbuttons, instruments, rheostats, indicating lights, relays, and other components can be installed—thanks to the ample space available on both the outer door and inner barrier.

Along with more room, this new A-C design is front accessible, has smaller cabinet size, provides ultimate in protection for men and machines, and has been completely tested.

For more information on this engineering advance, contact your A-C office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.



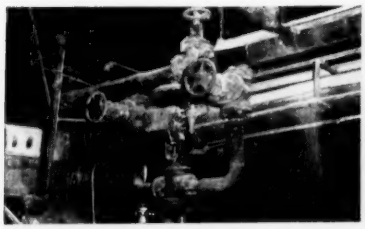
All this area on Allis-Chalmers new Type H motor control is available for optional features. In many applications, this extra space eliminates the need for an extra cabinet.

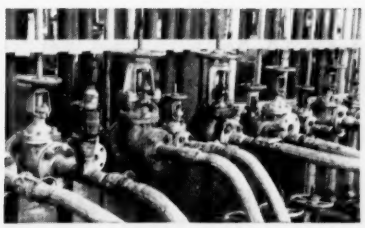
Removable panel, on which control devices are assembled, is mounted on inner barrier. Entire panel may be quickly removed for inspection and maintenance.

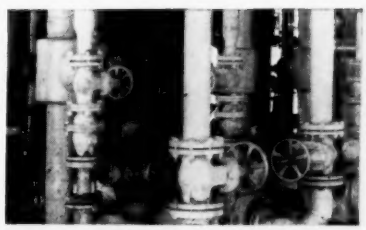
ALLIS-CHALMERS

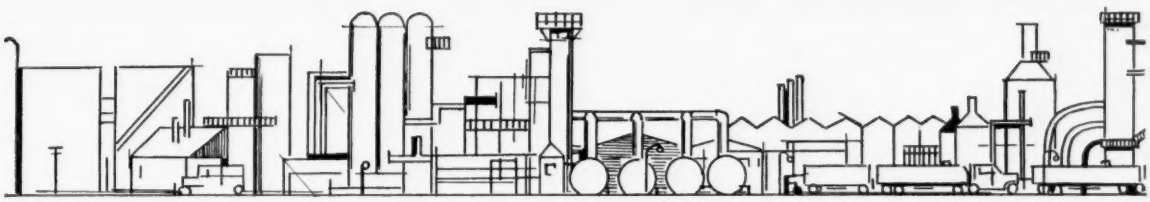
A-5519

How petrochemical producers trim costs with Stainless Steel valves









In petrochemical service, experience proves that Type 316 stainless valves help keep plants on stream at less cost. That's why many producers in this $5 billion-a-year industry specify Type 316 valves for the majority of their requirements.

DURABILITY MEANS ECONOMY

The superior resistance of Armco Type 316 to corrosion in acetic acid, ammonia and formaldehyde processing cuts valve replacement and maintenance costs. Valve parts made of Type 316 not only resist general corrosion but hydrogen embrittlement as well. They help prevent unexpected failures that can cause costly shutdowns and loss of production.

Type 316 stainless valves also provide lasting protection against contamination. This assurance of product quality is considered a real economy in plants producing polyethylene and other chemicals where purity is essential.

PERMITS ECONOMICAL STANDARDIZATION

Because valves made of Type 316 Armco Stainless perform so dependably in such a variety of exposures, many plants have found it economical to standardize on Type 316. This permits sizeable reductions in replacement stocks and greatly simplifies maintenance.

Put a curb on mounting costs by utilizing the plant-proved economies of Armco Stainless for valves and other processing equipment. Just fill out and mail the coupon or call your Armco Stainless Distributor for complete information on Armco's complete line of standard and special stainless steels for the chemical industry.

ARMCO STEEL CORPORATION
1568 Curtis Street, Middletown, Ohio

☐ Send me booklet, "Armco Stainless Steel Bar and Wire."

☐ We are considering stainless for_____.

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Company_____

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ARMCO STEEL

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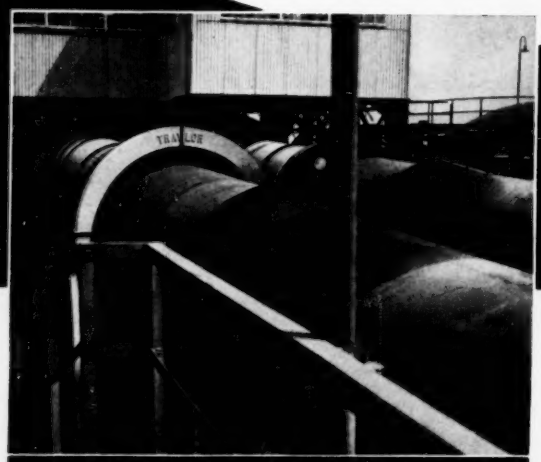
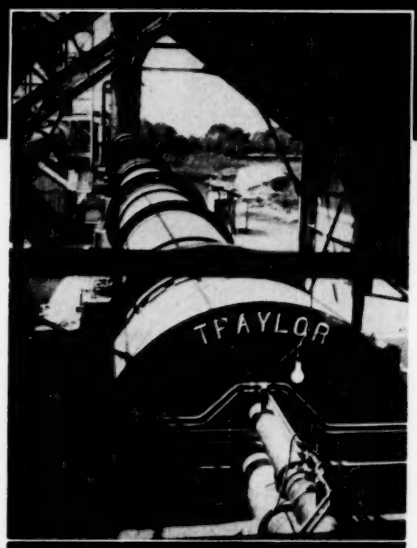
SHEFFIELD DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

Traylor-MADE KILNS



Two Traylor Rotary Kilns, 8'-0" diameter x 160'-0", in chemical processing plant.



8'-0" diameter x 160'-0" Traylor Rotary Kiln in paper plant.

Traylor engineers have established an enviable reputation for producing kilns that perform exceptional service at low cost for operators the world over. For over fifty years of kiln manufacture Traylor has pioneered and developed some of the outstanding features used in kilns today. One of the advancements made by Traylor engineers is the design and perfection of the easy aligning, single roller supports used on Traylor Rotary Kilns, Coolers, Dryers and Slakers.

"Full-floating" type of tire is one more Traylor Kiln advancement. Special mounting of these tires holds them securely in place but permits them to float free of the shell as it contracts and expands.

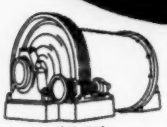
Call on Traylor's proven engineering ability to help solve your machinery problems—for more on Traylor Kilns write for bulletin #1115 today!

Traylor

TRAYLOR ENGINEERING & MFG. CO. 1020 MILL ST., ALLENTOWN, PA.

Sales Offices: New York — Chicago — San Francisco

Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P. Q.


BALL MILLS

ROTARY KILNS

APRON FEEDERS

PRIMARY GYRATORY CRUSHERS

JAW CRUSHERS

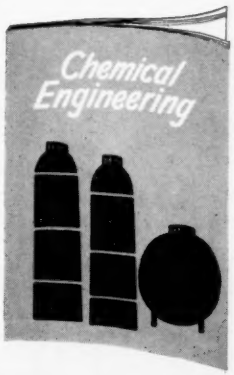
SECONDARY GYRATORY CRUSHERS

100% DuPont Nylon Carpet by Barwick Mills. Photo courtesy E. I. DuPont de Nemours & Co. (Inc.)

The Chemical Engineer makes 35,000,000 houses into homes

Synthetic fibers, furniture finishes, nylon upholstery, floor and wall coverings . . . all made possible by the Chemical Engineer and his technology.

The complex chemical process industries produce a multitude of products ranging from paper and plastics to synthetic fibers, rubber and wax. They are tied into a single market . . . buying a third of all manufacturing's capital goods, $46 billion in raw materials and fuels . . . by the critical presence of the chemical engineer as a common buying-specifying focus. As hundreds of advertisers know, successful CPI selling begins with him.



To sell the chemical engineer at his own home base, wherever it may be, only one way —CHEMICAL ENGINEERING—after 55 years still the 3 to 1 choice among chemical engineers in all functions, in all industries. This year you can reach him more often, with more timeliness and impact than ever before. CHEMICAL ENGINEERING, A McGraw-Hill Publication, New York 36, N. Y.

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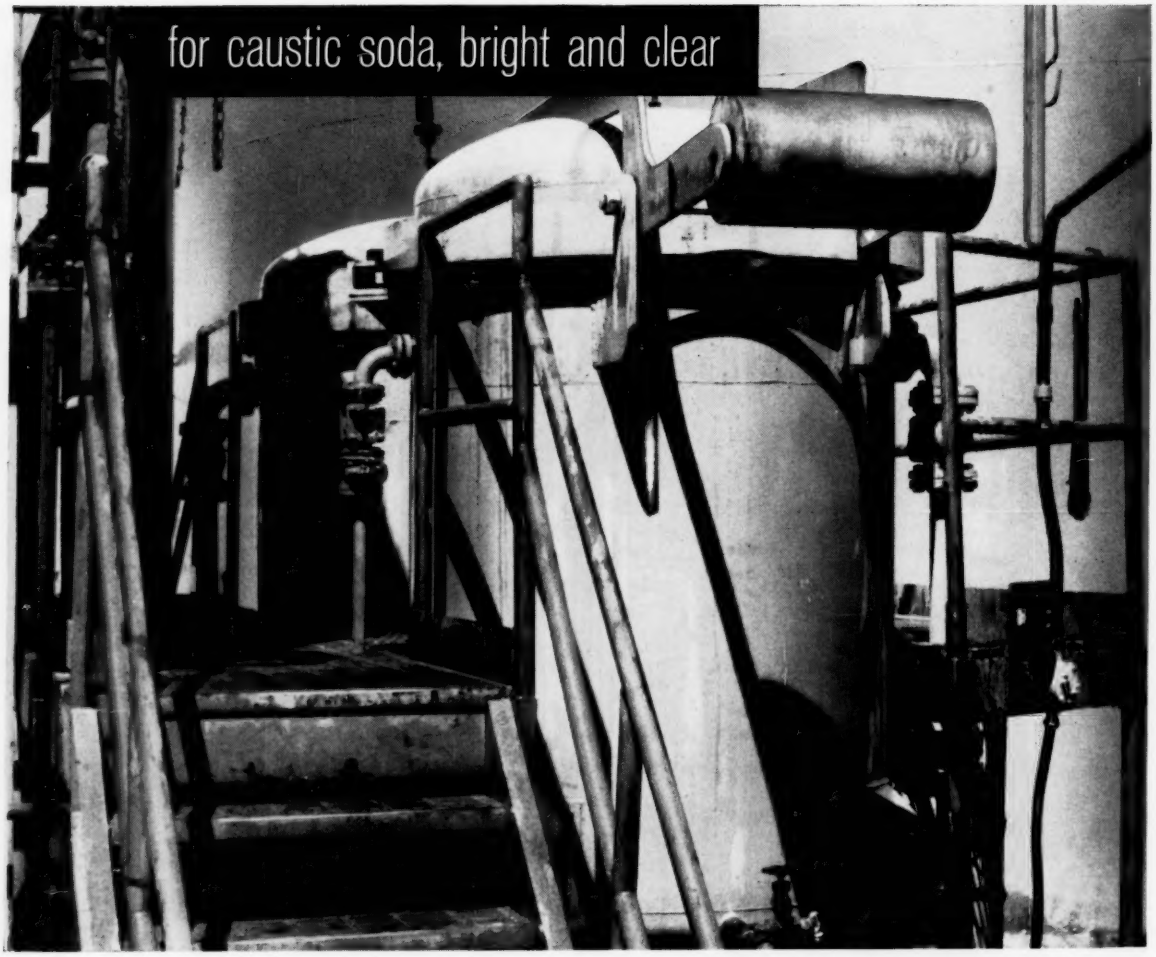


Stauffer picks Process Filters

To remove the final trace of turbidity from caustic soda, Stauffer Chemical Company installed two Process Vertical Pressure Leaf Filters at its Henderson, Nevada plant. Net result: "A bright, clear product for customers."

Says Stauffer: "PF Filters were selected after a survey of various pressure leaf filters and a series of pilot tests on this one. The equipment has been completely satisfactory as has been Process Filters' service."

Because of their efficient, time-saving performance, PF Filters are highly regarded throughout the chemical and petrochemical industries. Available in standard and specially engineered units with a wide range of accessories, they can be adapted to extremely diverse process conditions.

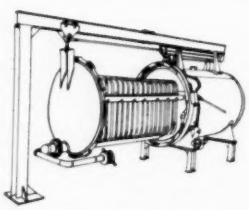
PF Filters are designed and built by forward-looking specialists who have come up with numerous filtration innovations: Rapid-Opening Covers, Quick-Change Cloth and Paper Bags, Automatic Leaf Shut-Off and Batch Recovery Leaves that provide twice the normal filtering area... to name a few.

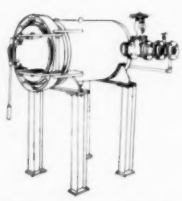
Why not get more facts on how Process Filters can boost your output at substantial savings? For specific information on one or more of the types shown below, request Bulletins listed.

Process Filters, Inc. *(A subsidiary of Bowser, Inc.)*
1807 Elmwood Ave., Buffalo 7, N.Y.

VERTICAL LEAF FILTERS
Bulletin V

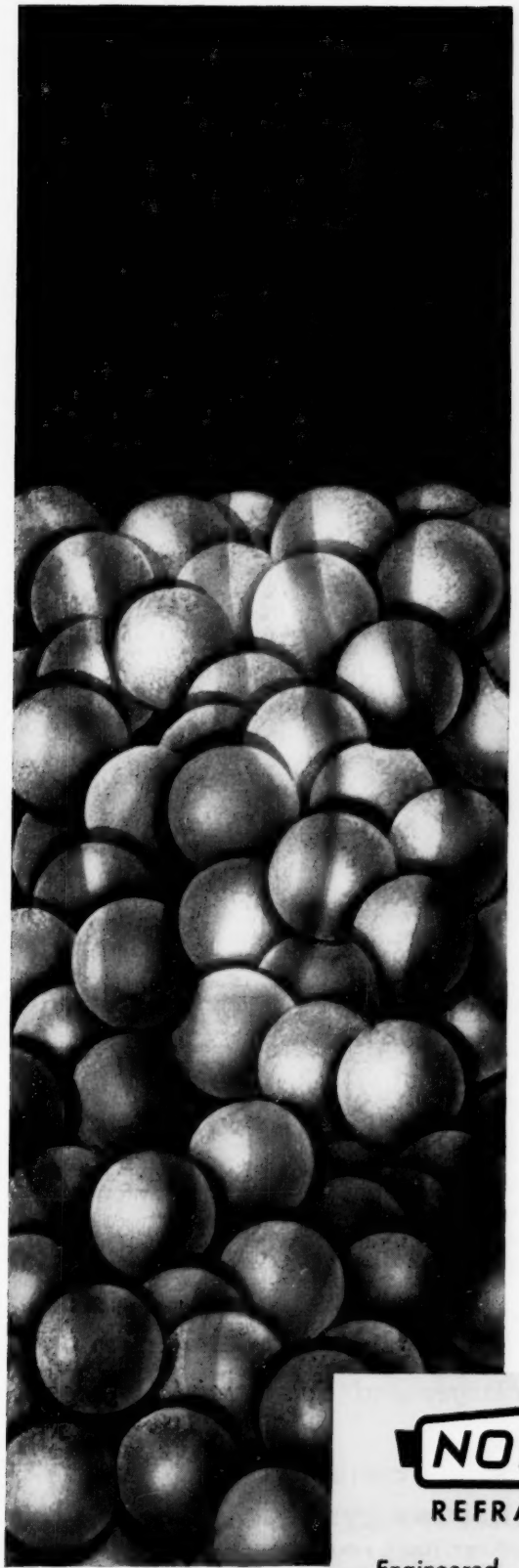
VERTICAL BATCH FILTERS
Bulletin VBO


HORIZONTAL LEAF FILTERS
Bulletin H


HORIZONTAL BATCH FILTERS
Bulletin HB

CARTRIDGE FILTERS
Bulletin C

pf



ALUNDUM*
Low Surface Area Catalyst Carriers
...add speed and efficiency to many processing reactions

Crystalline in nature, Norton ALUNDUM catalyst carriers have excellent mechanical, thermal and chemical stability. The most widely used type has low surface areas of less than $1 m^2/gram$, combined with high alumina content of 77% to 92%.

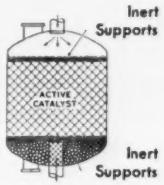
Shapes and Sizes: low surface area type; spheres 3/16" to 1½" diameter; pellets ⅛" x ⅛" to ½" x ½"; rings ⅛" x ⅜" x ⅜" O.D. to 1" x 1½" x 1½" O.D.

Other Physical Properties: apparent porosity 10-50%; water absorption 3-25%; bulk density 1.90-3.15 gr/cc; volume bulk density 65-80 lbs/ft^3; crystal structure alpha alumina and mullite.

Typical Applications: processing phthalic anhydride, maleic anhydride and ethylene oxide; also in protective atmospheres and synthetic gas generation.

Suspending active catalysts effectively

In fixed bed convertors, Norton inert supports are located to suspend active catalysts at given levels, as shown in diagram. Made of dense, rugged, electrically fused materials they have great resistance to breakdown and no chemically reactive effect on the processing.



Other carriers and supports

are produced by Norton with intermediate surface areas. On request, any type may be prepared from other materials, such as CRYSTOLON* silicon carbide, MAGNORITE* fused magnesia, zirconium oxide, silica, etc. For further facts call in your Norton Refractories Engineer, or write to NORTON COMPANY, Refractories Division, 502 New Bond Street, Worcester 6, Massachusetts.

*Trademarks Reg. U. S. Pat. Office and Foreign Countries.

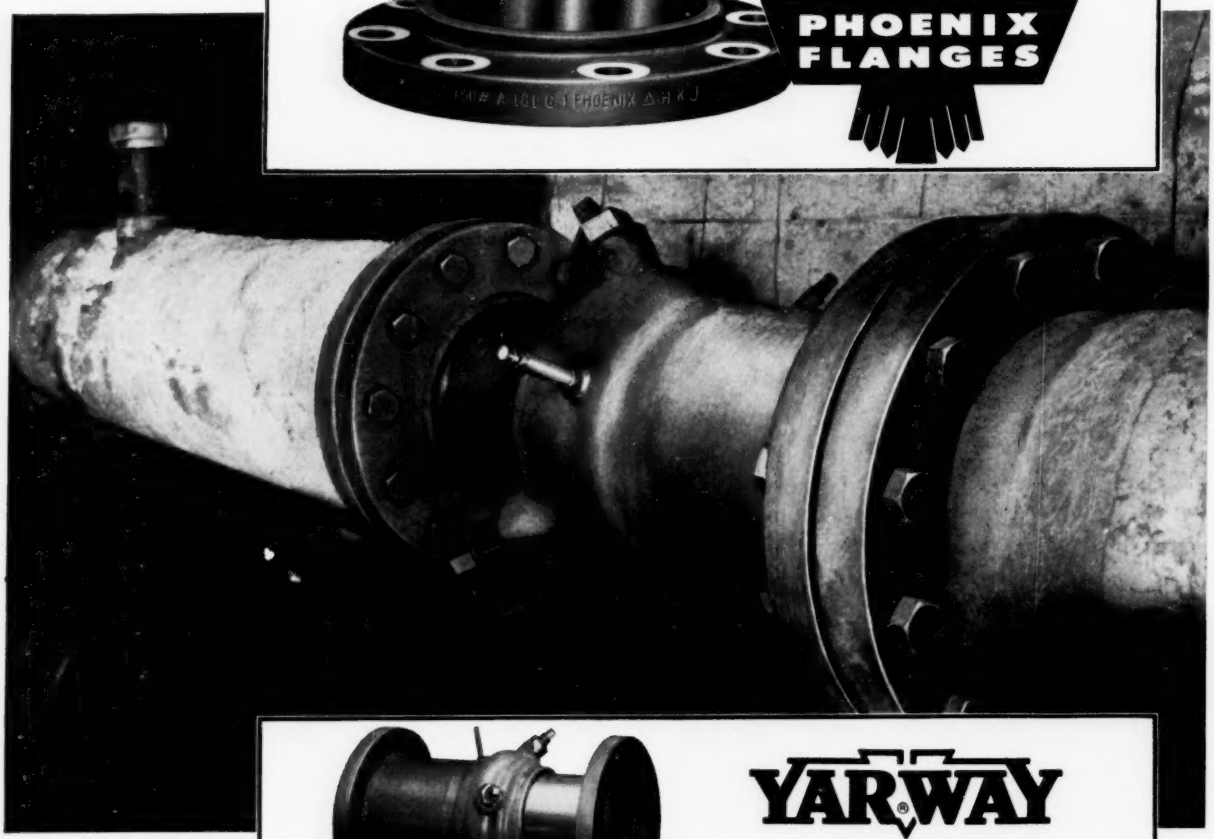
NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

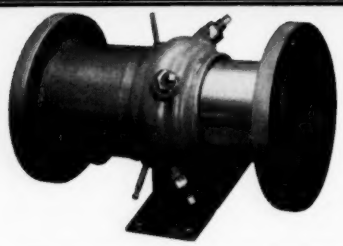
Making better products...
to make your products better

NORTON PRODUCTS
Abrasives • Grinding Wheels • Grinding Machines
Refractories

BEHR-MANNING DIVISION
Coated Abrasives • Sharpening Stones
Pressure-Sensitive Tapes

TWO QUALITY PRODUCTS TEAMED FOR AN EFFICIENT INSTALLATION





YARWAY

GUN-PAKT
EXPANSION JOINTS

Write for free 36-page pocket reference booklet

Because there is no need to shut down for repacking, the Yarway Gun-Pakt is one of the most popular expansion joints used in modern steam distribution lines. The Yarway joint is built for long service, with never any danger of metal fatigue or failure.

There must be no failure at flanged connections, either. That's why Yarnall-Waring Co. uses Phoenix forged-steel flanges on Gun-Pakt expansion joints.

Like Yarnall-Waring, you, too, will find that *you can't buy better flanges*. May we demonstrate the advantages of Phoenix service?

Leading Manufacturers of Pipe and Tank Flanges and Commercial Forgings

PHOENIX

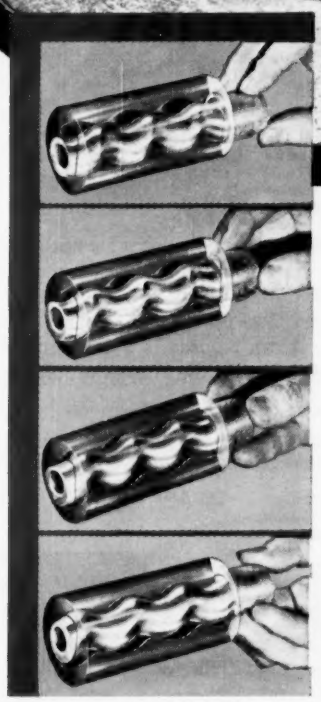
FLANGE AND FORGING DIVISION

PHOENIX MANUFACTURING COMPANY

CATASAUQUA, PA. • JOLIET, ILL. • FOUNDED 1882

Integrated Manufacturing Facilities: FLANGE AND FORGING DIVISION, STEEL MILL DIVISION, HORSESHOE PRODUCTS DIVISION, RUBBER PRODUCTS DIVISION

IF A CHEMICAL CAN BE PUSHED THROUGH A PIPE...A MOYNO® WILL PUMP IT!



■

Moyno's exclusive "progressing cavity" principle enables chemical plants to successfully pump hundreds of formerly "unpumpable" materials. These include highly abrasive or corrosive materials, ranging from thin watery slurries to extremely viscous material like rubber dough.

The screw-like rotor revolving in a double threaded stator moves material smoothly, without pulsation, turbulence or agitation. Because the rotor and stator can be constructed of special materials which resist wear, Moynos cut maintenance costs to a minimum.

No doubt Moynos can cut pumping costs for you!

Write for Bulletin 30-CE.

R&M

ROBBINS & MYERS, INC.

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KANIGEN® COATING

protects Hamer "VISIBLE WEDGE" Line Blinds

For positive shut-off in piping systems, engineers have long relied on Hamer Line Blind Valves. These absolute sealing valves provide substantial savings in time and product loss which often repay the cost of the valve in a surprisingly short period of time. When Hamer developed its series of Visible Wedge line blinds, an effective protection of the wedge surfaces against corrosion was desired. After thorough test and study, Kanigen nickel-alloy coating was selected for these surfaces. "Application of the Kanigen coating process," say the men at Hamer, "provides us with an effective corrosion barrier of this vital part, and greatly increases the service life of the valve."

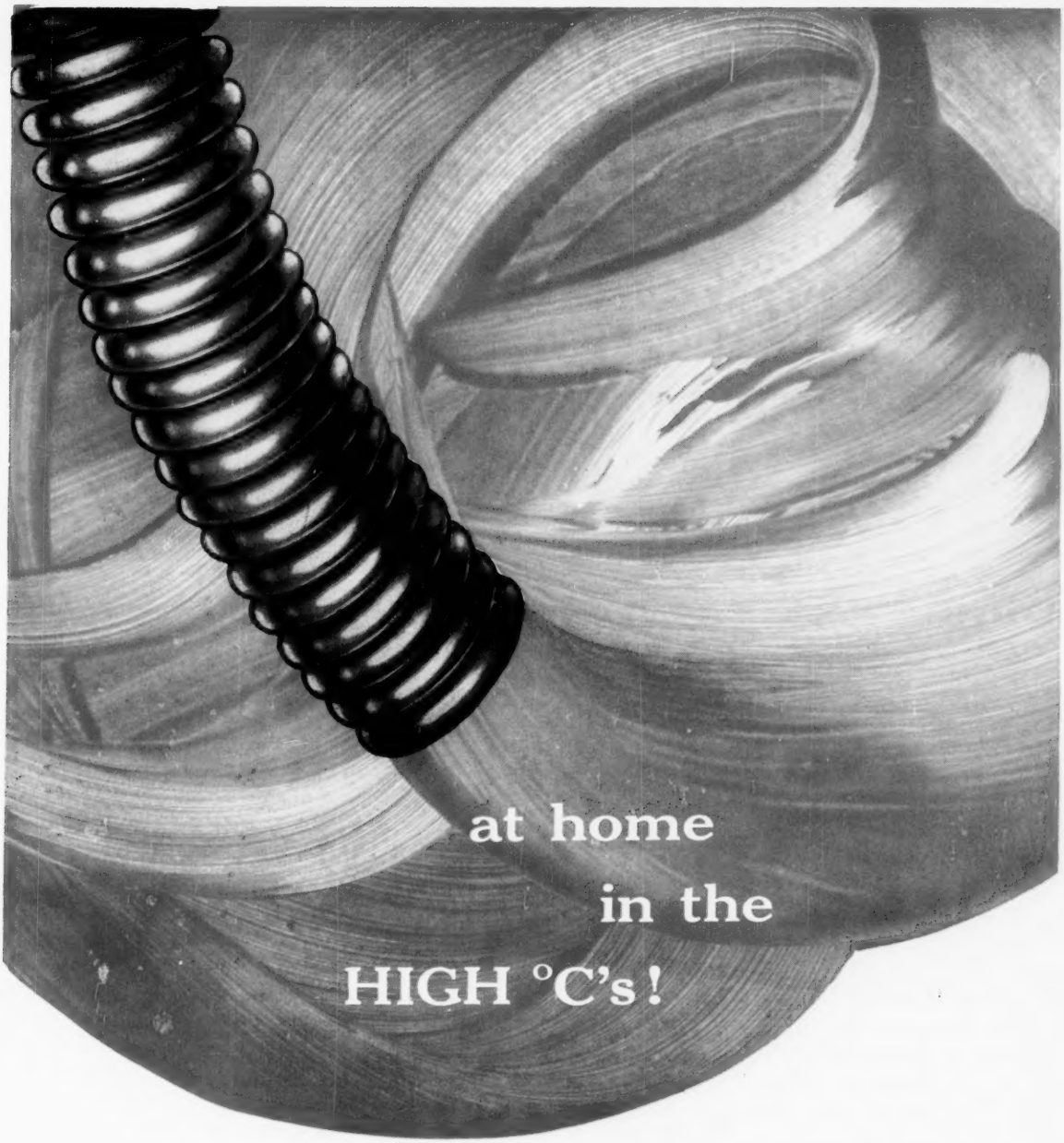
KANIGEN nickel alloy, chemically deposited as a hard, uniform coating, provides corrosion resistance and protection from product contamination wherever nickel is needed. Less costly than alloys, solid metals or clad materials, it can be used in a wide range of equipment—from small valves to the interior of huge tanks and dryers.

Equipment and parts can be jig-coated, rack-coated or barrel-coated at GENERAL AMERICAN plants at East Chicago, Indiana; Sharon, Pennsylvania, and Compton, California.

KANIGEN *is a trademark which identifies chemical nickel coating by GENERAL AMERICAN TRANSPORTATION CORPORATION and its licensees, the product resulting therefrom and compositions produced by them for use in chemical nickel coatings.*

KANIGEN DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South La Salle Street • Chicago 90, Illinois

KANIGEN GENERAL AMERICAN TRADE MARK



PUT ATLANTIC FLEXIBLE STAINLESS STEEL HOSE TO WORK in any inferno of high temperature and high pressure corrosive gases and liquids. It Stands Up! . . . Every inch . . . JOB TESTED & CERTIFIED . . . for unequalled leakproof qualities, durability, strength and lightness. Use it to control movement and vibration . . . correct misalignments . . . to compensate for expansion and contraction . . . in process lines . . . for loading and unloading.

Available in sizes ¼"-4" I.D. inclusive with appropriate fittings. Produced in various alloys of stainless steel —— in monel, bronze, and carbon steel. Write for Bulletin 21-A. See our Catalog in Sweet's File for Product Designers.

ATLANTIC METAL HOSE CO., INC.

329 Dyckman Street, New York 34, N.Y.

The last word on

VAPOR COMPRESSION EVAPORATORS

From:
Cleaver-Brooks Company
Special Products Division
225 Grand Avenue
Waukesha, Wisconsin

Field proved by years of service providing fresh pure water in 22 countries around the world
Cleaver Brooks
Cleaver Brooks
VAPOR
COMPRESSION
EVAPORATORS
CLEAVER-BROOKS COMPANY, Special Products Division

Here's the low-cost answer to your pure water problems. Cleaver-Brooks units are famous for economical operation, produce distilled water for energy-cost as low as 51 cents per thousand gallons.

Fresh water from the sea or brackish wells for municipal use in desert areas . . . Cleaver-Brooks vapor compression units produce pleasant tasting water. Thousands field-proven for dependability and efficiency. Capacities range from 1000 to 50,000 gallons per day.

Pharmaceutically pure water — Vapor compression is especially suited to producing pyrogen-free water for pharmaceutical applications or industrial water distilling. Cleaver-Brooks now serves leading laboratories.

Concentration of radioactive wastes — Special designs available for concentrating radioactive wastes. Over 99.99% of the radioactivity is retained in the sludge.

Cleaver-Brooks offers many types of units engineered to answer "concentration-for-recovery-or-disposal" problems in chemical and processing industries.

For up-to-the-minute information on vapor compression evaporation return coupon today.

CLEAVER-BROOKS COMPANY, *Special Products Division*
225 Grand Ave., Dept. CE-38, Waukesha, Wisconsin

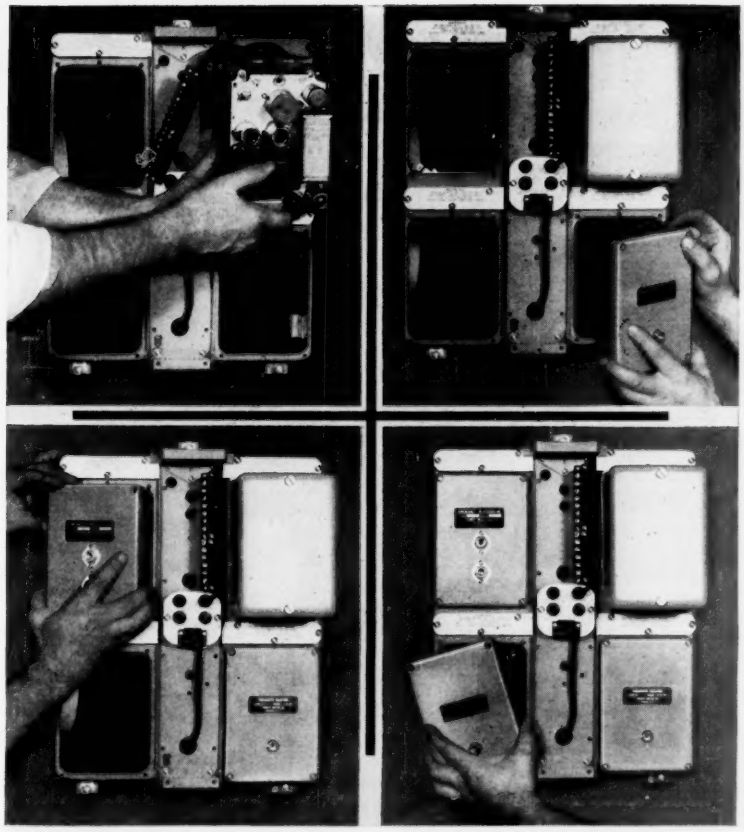
- ☐ Please send me your Vapor Compression Catalog
- ☐ I would like to discuss evaporation problems with a Cleaver-Brooks sales engineer

Name .....
Firm .....
Street address .....
City ..... State .....

Cleaver Brooks®

Builders of equipment for the generation and utilization of heat

CUSTOM BUILD your own Bailey Recorder



These four views of the back of a Bailey Recorder show how four plug-in units may be added as needed to meet almost any recorder application.

The freedom and flexibility of "do-it-yourself" instrumentation is yours in the Bailey Recorder. A variety of plug-in units make it possible to record, control, and retransmit any variable that can be converted to a pneumatic or electric signal.

The basic plug-in units are the Bailey a-c and d-c Electronic Receivers and Pneumatic Receivers. Any four of these may be used in one recorder, intermixed in any way, to provide four continuous records on one chart.

For automatic control, other plug-in units are available.

For square root extraction or linear integration, there are two plug-in variations of the Bailey Integrator.

When you want a pneumatic signal that varies according to a pre-set pattern plug in a Bailey Program Controller.

Periodic running time of a condition or process is recorded on the chart when a Bailey Running Time Recorder is used.

These and other plug-in units are described in Product Specification E12-5. Some companies stock Bailey Recorder cases and assorted plug-in units. As instrumentation and control needs arise they build up the kind of recorder-controller required, using the proper plug-in units from stock. Unmatched versatility such as this means lower instrumentation costs.

For the complete story of how easily you can custom build this recorder to your needs, see your Bailey Engineer. G43-1

BAILEY METERS

Instruments and controls for power and process

BAILEY METER COMPANY

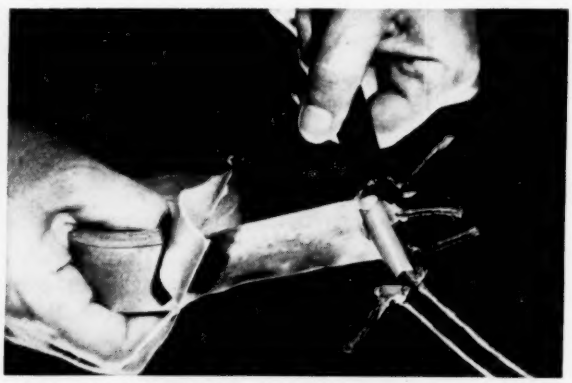
1054 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

HOW *HERCULES* HELPS...

MAINTAIN QUALITY STANDARDS—For generations "Evenflo" baby bottles have been a recognized leader in their field. Now Pyramid Rubber Company uses Hercules Hi-fax® high density polyethylene to mold "Evenflo" plastic bottles with even more advantages. Unbreakable, of course, Hi-fax bottles are acceptable by FDA for direct contact with food, can withstand the high temperatures necessary for sterilization. These are just a few reasons why Hi-fax is finding ever increasing use in packaging, toys, fabrics, wire coating and pipe.

ENCOURAGE YOUTH—Pictured with Hercules Vice President Paul Mayfield are winners in the National 4-H Entomology Awards Program. Agricultural Chemicals Division thus plays a part in the development of farm and civic leadership.



CREATE NEW PRODUCTS—Rubber and Asbestos Corporation depends on two Hercules tackifying agents for the unique characteristics of its new "Tackmaster" pressure-sensitive film used in the tape shown. The Hercules materials help provide the high tack, quick stick and grab necessary in such films, plus easy separation from the protective release paper.

HERCULES POWDER COMPANY
INCORPORATED
900 Market Street, Wilmington 99, Delaware

G58-2

CHEMICAL MATERIALS FOR INDUSTRY

HERCULES

Mister, you're looking at a panelboard that's really built for Heavy Duty!

The heart of this QMB Saflex Distribution Panelboard is the quick-make, quick-break, horsepower rated switch unit.

It's loaded with features—

- Each switch unit individually enclosed in heavy gauge steel
- Dead front construction
- Heavy duty cast operating handle
- Double-spring mechanism insures positive opening under full load
- Visible blades for maximum safety
- Positive pressure fuse clips and switch jaws assure maintenance-free connections
- Cover interlock prevents unauthorized access but makes normal maintenance easier

QMB Saflex Distribution Panelboard

Here's a panelboard that's built for the tough jobs! But it goes a lot further than rugged construction. It's designed with plenty of space for easier wiring and maintenance.

Write for...

Bulletin S D-29 for further information
Address: Square D Company,
6060 Rivard Street,
Detroit 11, Michigan

NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE!

SQUARE D COMPANY

Keep plant space flexible with BLAW-KNOX Electroforged® Steel Grating

If expanding production set-ups are cramping feeder and storage areas in your plant, it will pay you to check into Blaw-Knox Electroforged Steel Grating.

Storage platforms of Blaw-Knox steel grating put unused space to work easily, economically. There's nothing to wear, nothing to patch. Blaw-Knox Electroforged grating fits neatly around pipes, beams and machinery without any alterations to the building, and, at the same time, admits maximum light and ventilation to the entire area.

Blaw-Knox Electroforged Grating for walkways, stair treads and floors is fabricated to your specifications to meet your own operating conditions. Complete data on all types is contained in Bulletin No. 2527. Write for your copy today.

BLAW-KNOX COMPANY

Equipment Division
Dept. C, Pittsburgh 38, Pa.

BAD AIR IS COSTLY...

... as compared to the blower that keeps air fresh

Your men can't produce at top efficiency when stagnant, hot or fume-filled air robs them of their energy.

Wherever bad air slows down production . . . in shipholds, tanks, drums, boilers or other places where men need fresh, cool air . . . a Coppus Blower becomes both a safety device and a production tool.

Portable and easily adaptable for special purposes, Coppus "Blue Ribbon" blowers and Exhausters fit all your "fresh air" requirements. The Coppus "Blue Ribbon" means premium performance at ordinary cost. Check and mail the coupon for specific information. Sales offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG, BEST'S SAFETY DIRECTORY, MINING CATALOGS.

OTHER
COPPUS
"BLUE RIBBON"
PRODUCTS

HORIZONTAL TURBINE
Six frame sizes—
1 to 150 horsepower

VERTICAL TURBINE
Six frame sizes—
1 to 150 horsepower

FANMIX GAS BURNER

FANMIX GAS-OIL BURNER

MAIL THIS COUPON! **To Coppus Enginering Corp., 223 Park Aveune, Worcester 2, Mass.**

PLEASE SEND ME INFORMATION ON SUPPLYING FRESH AIR TO MEN WORKING:

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fusilages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.
- ☐ drying of walls, sheets; etc., after treated with coating material.

NAME.....

COMPANY.....

ADDRESS.....

CITY.....

(Write here any special ventilating problem you may have.)

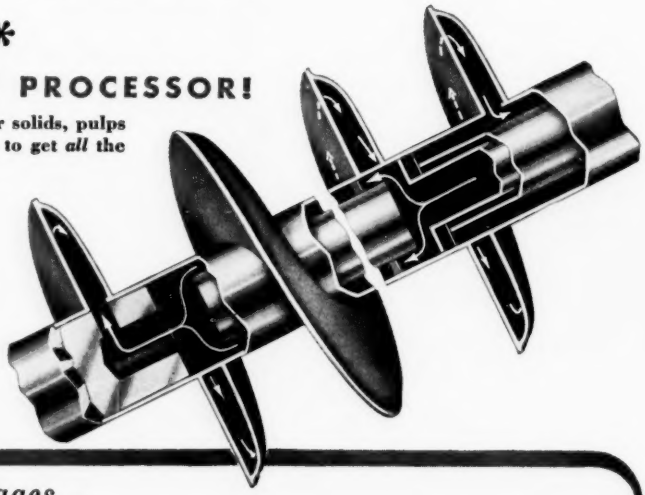
if you have a Cooling...Heating...or Drying problem

investigate the revolutionary advantages of...

THE holo-flite* PROCESSOR!

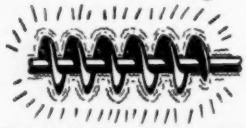
If you have processes where slurries, granular solids, pulps or pastes are cooled, heated or dried, be sure to get *all* the facts on HOLO-FLITE advantages.

HOLO-FLITE handles such processes — *in continuous flow* — in as little as 1/5th the space of other types of heat exchangers. What's more, it is readily adaptable to a wide range of applications — is simple to install and maintain — and provides many other important savings.

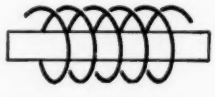


typical HOLO-FLITE *advantages...*

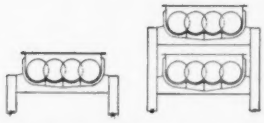
ITS APPLICATION FLEXIBILITY is almost unlimited. It cools, heats, or dries. It handles granular solids, pulps, pastes, slurries and fluids with equal ease. Its heat transfer agent can be water, refrigerant, hot oil, Dowtherm, steam or other liquids or vapors at any of a wide range of temperatures. It cools materials in ranges from 1800°F to 0°F. It heats and dries with hot oil to 600°F...with Dowtherm to 750°F...with steam to 150 lbs. per sq. in. pressure.



THE LARGE HEAT-TRANSFER SURFACE saves space — HOLO-FLITE requires as little as 1/5th the space of other heat-exchange equipment of comparable capacity. Moreover, a more complete heat transfer is effected, resulting in more uniform processing.



ROTATION IS SLOW — granular and powdered solids are handled with practically no dusting — negligible abrasion. There are no dust recovery problems — a further saving in installation, maintenance and operating costs!



ITS OPERATING CAPACITY is readily adaptable to virtually any requirements by simply varying the diameter, pitch, and length of flights, as well as the number of "tiers." Multi-tier units require no more floor space than single-tier installations!

Send for a Free 8 Page Bulletin which gives further time, space and money-saving details on Holo-Flite installation and operating advantages!

*T.M. Reg. (HOLO-FLITE)

HOW HOLO-FLITE WORKS...

Basically the HOLO-FLITE consists of one or more flights of hollow-bladed screw conveyors. The product to be processed moves through a trough housing the conveyor screws. The heat-transfer fluid circulates through the hollow blades and shafts of the conveyor. The product is constantly rotated into, around, under and over the blades and shafts through which the heat-transfer fluid is circulating, assuring quick, uniform heat passage between the two mediums — *as the product is continuously moved along in a bulk-flow without interruptions!*

There are many money and time-saving applications for the Holo-Flite wherever products are cooled, dried, heated or even calcined. Let our engineers study your *particular* problem and make helpful recommendations. No obligation, of course!

wp

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
HOLO-FLITE Processors
HI-TURBIANT Heaters

WESTERN
PRECIPITATION
CORPORATION

Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

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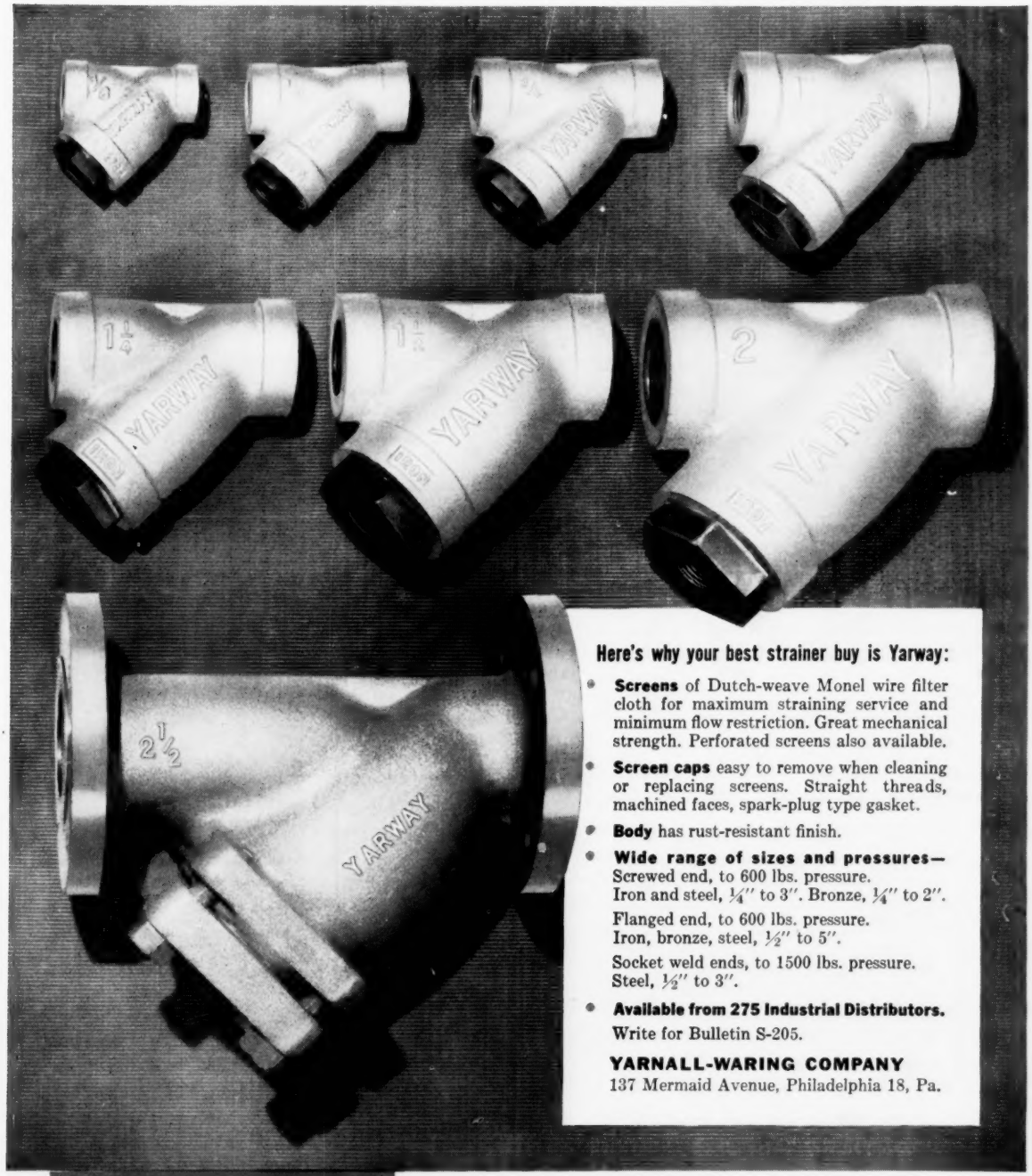
Representatives in all principal cities

Precipitation Company of Canada Ltd., Dominion Square Bldg., Montreal

BETTER PIPELINE STRAINERS

...BY YARWAY



Here's why your best strainer buy is Yarway:

- **Screens** of Dutch-weave Monel wire filter cloth for maximum straining service and minimum flow restriction. Great mechanical strength. Perforated screens also available.
- **Screen caps** easy to remove when cleaning or replacing screens. Straight threads, machined faces, spark-plug type gasket.
- **Body** has rust-resistant finish.
- **Wide range of sizes and pressures—**
  Screwed end, to 600 lbs. pressure.
  Iron and steel, ¼" to 3". Bronze, ¼" to 2".
  Flanged end, to 600 lbs. pressure.
  Iron, bronze, steel, ½" to 5".
  Socket weld ends, to 1500 lbs. pressure.
  Steel, ½" to 3".
- **Available from 275 Industrial Distributors.**
  Write for Bulletin S-205.

YARNALL-WARING COMPANY
137 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY . . . *a good way to specify strainers*

No Guesswork When Laboratory Crushing or Grinding is Done by Sturtevant Machines

"Open-Door" Design Provides Quick Access for Cleanout — Guarantees Accurate Samples

Sturtevant Automatic Coal Sampler at Con Edison's Laboratory (New York). Sturtevant Bulletin No. 85 describes this machine.

In a matter of seconds, because of hinged access doors, all crushing or grinding parts are exposed for thorough cleanouts — 100% accuracy in sampling.

Design of Sturtevant laboratory machines is based on production models. Higher output — to scale with actual production quality and output, is built into each machine. Add rugged construction and you have a machine that keeps on top of lab or pilot work.

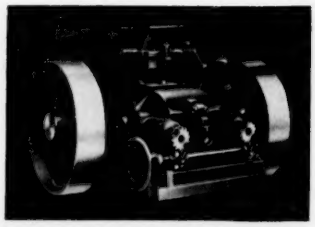
Preferred by laboratories that demand accuracy and dependability in test or pilot runs, Sturtevant laboratory machines have long been used by the 'blue chips' of industry and education. Names on request.

Send for Bulletin 067, which gives full description of all Sturtevant laboratory machines. (Bulletins are also available on Production Crushers, Grinders, Blenders, Air Separators, Micronizers and Automatic Coal Sampler.) Write Sturtevant Mill Company, 100 Clayton St., Boston 22, Mass.

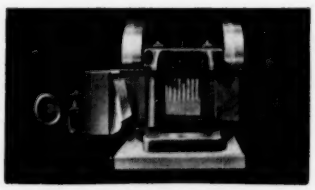
SWING-SLEDGE MILL RETIRES AFTER 25 YEARS . . .

Ruggedness of Sturtevant machinery is well-known in industry, where even laboratory-size Sturtevant units are sometimes used for round-the-clock production.

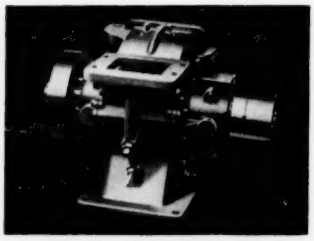
Jas. F. Morse Co., Boston, recently replaced their small-size Swing-Sledge Mill, which had been doing production grinding for 25 years. It was used to grind ⅝ in. tankage into bone meal. Repairs in 25 years? "Just grates and hammers," reports Plant Manager W. Carleton Merrill.



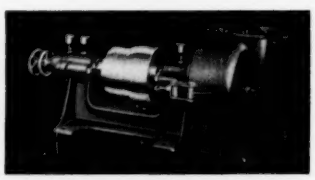
Lab Crushing Rolls: Specially designed for laboratory sampling, Crushing Rolls come in two sizes: 8 x 5 in. and 12 x 12 in. Capacities run as high as 10 tons per hour. Automatic adjustments: 8 x 5 in. model adjusts from ½ in. to 20 mesh; 12 x 12 in. model from ¾ in. to 20 mesh. Tires are high carbon forgings and extra tough. Feeder is automatic, adjustable.



Lab Jaw Crusher: Full or part-time duty for crushing hardest rocks: 2 x 6 in. opening Jaw Crushers have roll jaw action — no clogging. Hard rock capacities: ½ in. setting — 1900 pounds per hour; ¼ in. setting — 1200 pounds per hour; ⅛ in. setting — 800 pounds per hour. Instant in-operation adjustment. Jaw Crushers have manganese steel jaw plates, reversible shields, steel pitman, anti-friction bearings.



Lab Swing-Sledge Mill: 5 x 6 in. feed opening takes soft, medium, tough or fibrous material. Capacity to 1 ton per hour, fines regulated from 1 in. to 20 mesh. Single-pass limestone grinding produces 99.8% 10 mesh fines, 95.8% 20 mesh. Single-pass bituminous coal pulverizing gives 99.9% 10 mesh fines, 91% 20 mesh. Choice of gratings, hammers (or knives).



Sample Grinder: Disc type grinders for dry, friable, soft or medium materials. Three sizes — 6 in., 10 in. and 14 in. take feed as coarse as ¼ in. 100 mesh fines at rates to 200 pounds per hour on largest model. Product regulates from 10 to 100 mesh. In-operation adjustment.

STURTEVANT

Dry Processing Equipment

The "OPEN-DOOR" to *lower* operating costs over *more* years

CRUSHERS • GRINDERS • MICRON-GRINDERS • SEPARATORS
BLENDERS • GRANULATORS • CONVEYORS • ELEVATORS

NEWEST OF THE GARLOCK **2,000**

SURFACE
Treated with elastomeric binder and powdered graphite . . . serves as a surface leveling and friction reducing element.

JACKET
90% asbestos yarn reinforced with 2 strands of inconel wire for corrosion resistance as well as maximum heat resistance.

CORE
Long fiber asbestos, graphite, and a corrosion inhibitor all bonded together in a way which assures flexibility.

NEW valve stem packing... STYLE 127 for high pressure, high temperature Service

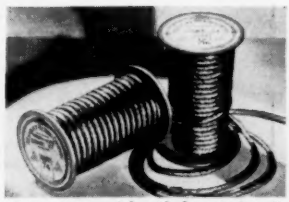
Here's an outstanding valve stem packing which is ideally suited to extreme steam conditions. Withstands pressures of 4000 psi., and steam temperatures to 1200°F. as long as stuffing box itself does not exceed 750°F. It is unsurpassed as a high temperature oil refinery or steam power plant packing.

This Style 127 Valve Stem Packing is the newest member of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals to meet all your needs. It's the only complete line. That's why you get unbiased recommendations from your Garlock representative. Call him . . . ask about the new Style 127.

OTHER GARLOCK VALVE STEM PACKINGS

Style 5855—Similar to 127, but for lighter duty. Costs less, too.

Style 17—A braided asbestos yarn treated to resist steam at high pressures and temperatures to 600°F.



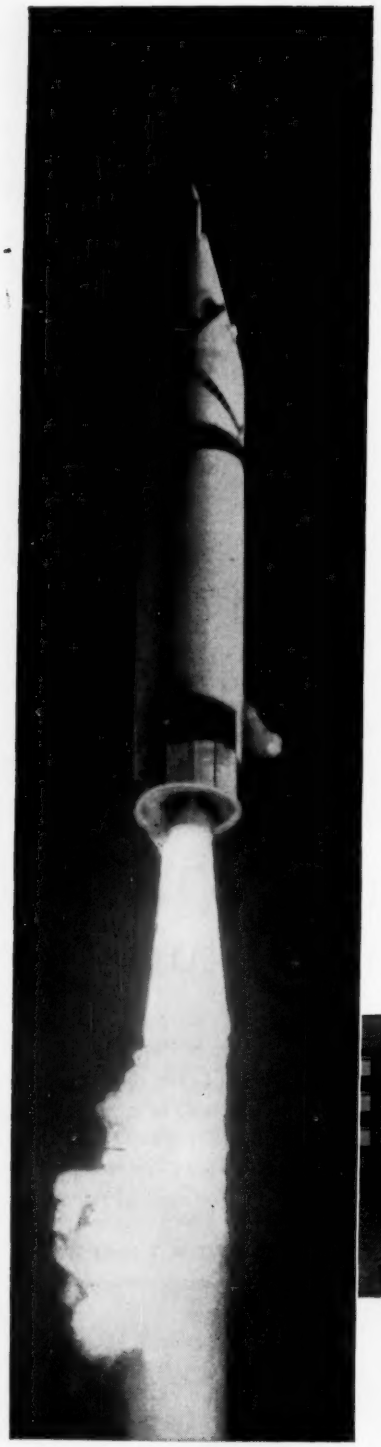
Style 117—A braided (or twisted) asbestos yarn treated for service against steam at low to medium temperatures.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products



When the stakes are high...

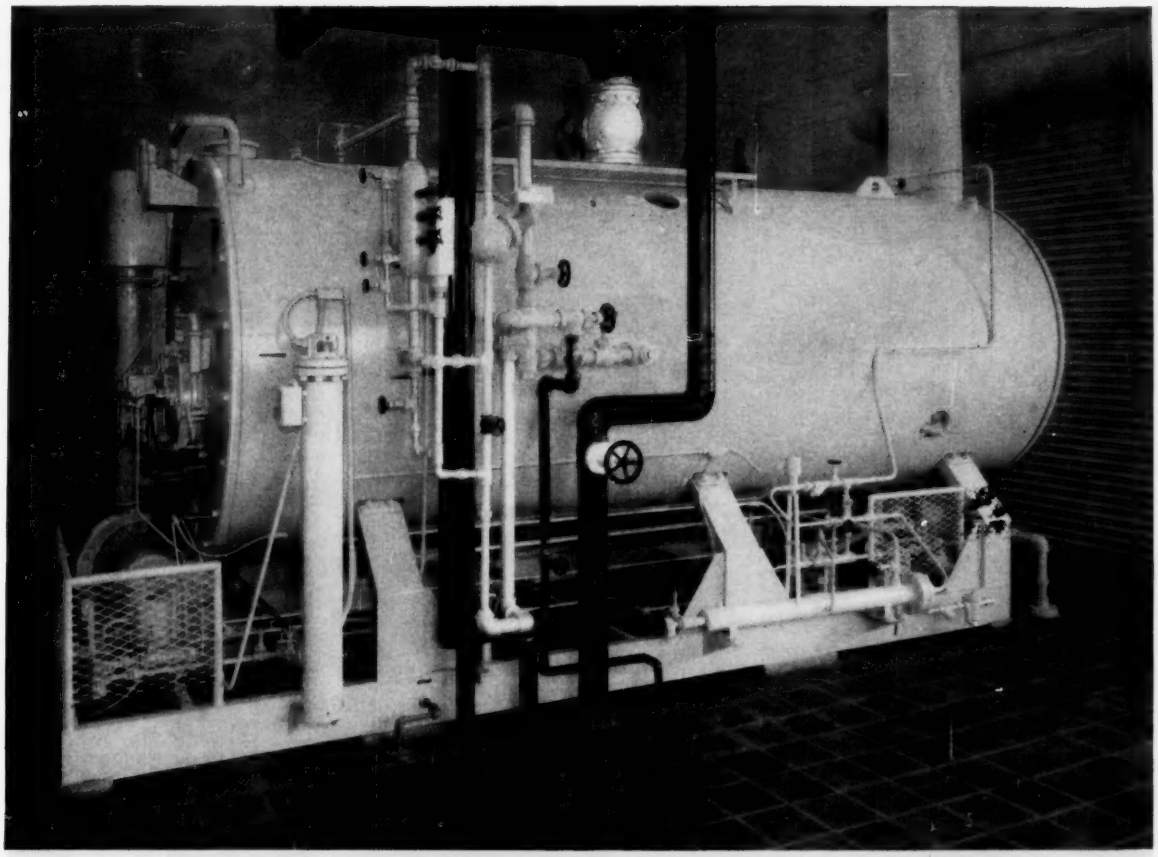
"Accuracy, reliability and versatility are the major considerations for instrumentation here at Redstone," says Fritz Weber, Chief of the Instrumentation Test Section, Army Ballistic Missile Agency. "During tests that may involve hundreds of thousands of dollars in equipment, supplies and manpower, a failure of the data recording equipment can result in a total loss of the run.

"In our strip chart recording room, we have over a hundred L&N Speedomax G modified adjustable instruments. All are equipped with retransmitting slidewires so that data can be fed into a Millisadic data system for storage and transmission to IBM equipment. Recorders are so equipped that they can be controlled from a central console. There, the operator can select the test site from which data is to be received and the method of data handling to be used. Before a test is started up, all 132 recorders can be standardized by a single button."

Vital data on Jupiter and Redstone Missile assemblies are supplied by 132 Speedomax G precision Recorders. As part of an exhaustive testing program, these data help guide ABMA's scientists in missile-firing.

"New Horizons", *L&N's Tech. Pub. ND46 gives data on circuitry, and performance characteristics of Speedomax instruments. Get a copy from your nearest L&N Office or from Leeds & Northrup Co., 4916 Stenton Ave., Phila. 44, Pa.*

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces



200 HP AMESTEAM GENERATOR Installation at U. S. Concrete Pipe Co.

LOW COST STEAM DELIVERED BY AMESTEAM GENERATORS

BRINGS REPEAT ORDERS FROM U. S. CONCRETE PIPE

Why is it that AMESTEAM GENERATOR customers are almost always *repeat* customers? The reason can be summed up in these words: "Lower Cost Steam". One of these repeat customers is U. S. Concrete Pipe Co., Relay, Md. This firm is one of the leading producers of large concrete drainage pipe and allied products.

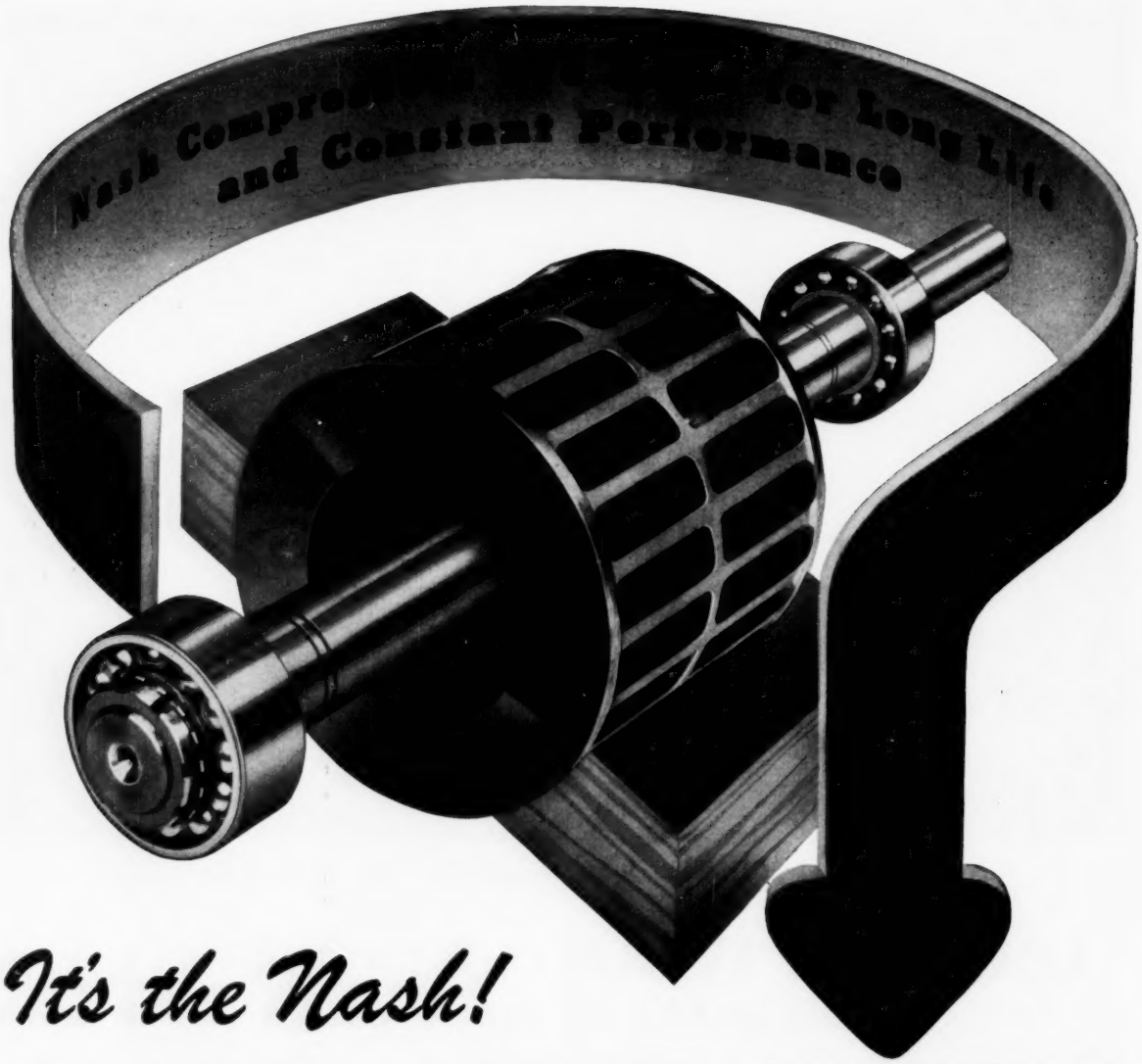
Recently the company needed a boiler to supply steam for the structural curing of various concrete products. Successful experience with the AMESTEAM GENERATOR "Package" Boilers proved elsewhere in other plant operations led to selection of the 200 HP unit shown above. U. S. Concrete Pipe found that this AMESTEAM GENERATOR provides the most economical and efficient solution to this important steam problem.

Here is another of the hundreds of users whose complete satisfaction with AMESTEAM's low-cost, dependable performance is indicated by the repeat orders we continue to receive from them. This record for repeat orders is based on AMESTEAM GENERATOR's reputation for *Low Cost Steam,* faithfully delivered over a long period of years.

What's YOUR Steam Problem?

If you need 10 to 600 HP and want the kind of space-saving, trouble-free service enjoyed by satisfied owners of AMESTEAM GENERATORS, write today for our catalog and the name of your nearby Amesteam Dealer.

AMES IRON WORKS, INC.
Box S-38 Oswego, N. Y.



It's the Nash!

The ability of Nash Compressors to maintain original performance over long periods is no accident. Nash Compressors have but a single moving element, the Nash Rotor. This rotor is precision balanced for long bearing life, and it revolves in the pump casing without metallic contact. Internal lubrication, frequent cause of gas contamination, is not employed in a Nash. Yet, these simple pumps maintain 75 lbs. pressure in a single stage, and afford capacities to 6 million cu. ft. per day in a single compact structure.

Nash Compressors have no valves, gears, pistons, sliding vanes or other enemies of long life. Compression is secured by an entirely different principle of operation, which offers important advantages often the answer to gas handling problems difficult with ordinary equipment.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. Because there are no internal wearing parts, maintenance is low. Service is assured by a nation-wide network of Engineering Service offices. Write for bulletins now.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature Automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

312 WILSON, SO. NORWALK, CONN.

Keeping them white... from the inside out

with DARCO® ACTIVATED CARBON

The sporty look of whitewalls could be spoiled by dark-colored oils in the inner casing, which tend to bleed through and cause unsightly stains. To prevent this, tire makers hit on a novel use for the adsorptive power of DARCO activated carbon. They put a small amount of DARCO in the black rubber where it entraps any oils that come creeping through ...acting like a trap for migrant impurities.

Adsorbing impurities . . . colors, odors, floc-precursors, colloids . . . is the useful talent of DARCO activated carbon. And putting this versatile process to work to upgrade product quality is an Atlas specialty.

We've been in the adsorption business for nearly 40 years, so we'll know how to figure out ways to tackle your specific adsorption problem. You'll be sure of getting the exact kind of carbon you need, for we make nine specialized grades of DARCO.

If you have an idea how or where impurity removal might be useful in the products you're developing or making, write for Darco Data or give us a call. We'll be glad to help you.

CHEMICALS DIVISION
ATLAS POWDER COMPANY
WILMINGTON 99, DELAWARE

In Canada: Atlas Powder Company, Canada, Ltd.
Brantford, Ontario, Canada

DARCO

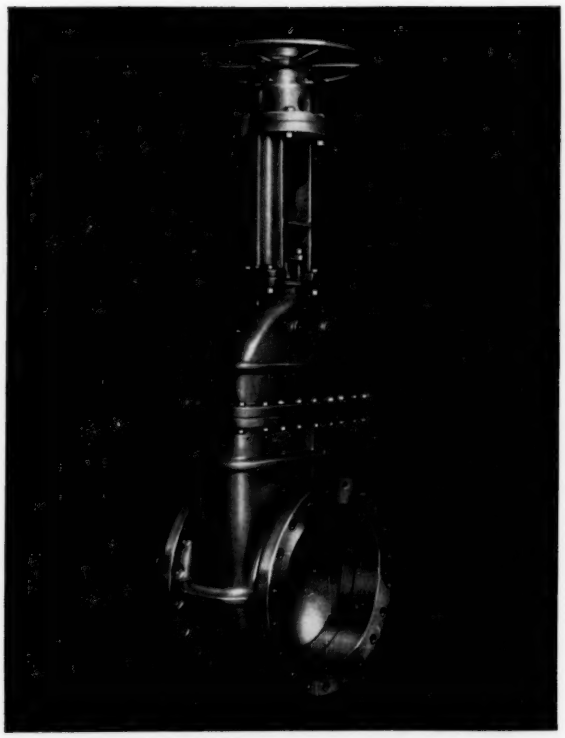
REG. U. S. PAT. OFF.

ALUMINUM GATE VALVES

BY DARLING

FEATURING:

unmatched advantages of DARLING fully revolving double disc parallel seat gate valve principle!



There's new economy to be gained in the handling of "problem" fluids and gases with Darling aluminum alloy gate valves . . . now available in ½" through 24" sizes. We have data on initial and long-range costs and performance that will interest you. Write for facts.

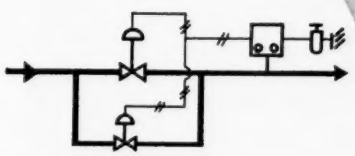
DARLING VALVES

DARLING VALVE & MANUFACTURING CO.

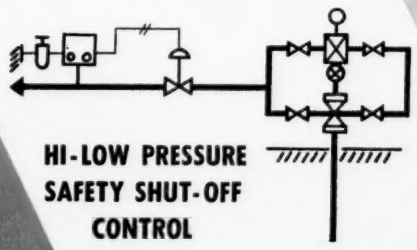
Williamsport 3, Pa.

For Optimum Pressure Control, Specify BS&B 72-14 Pressure Controllers And Transmitters!

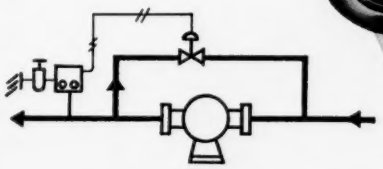
Proportional ⋆ On-Off ⋆ Differential Gap
Indicating Or Non-Indicating



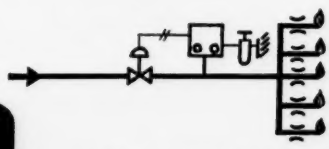
PRESSURE REDUCING CONTROL



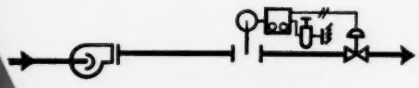
HI-LOW PRESSURE SAFETY SHUT-OFF CONTROL



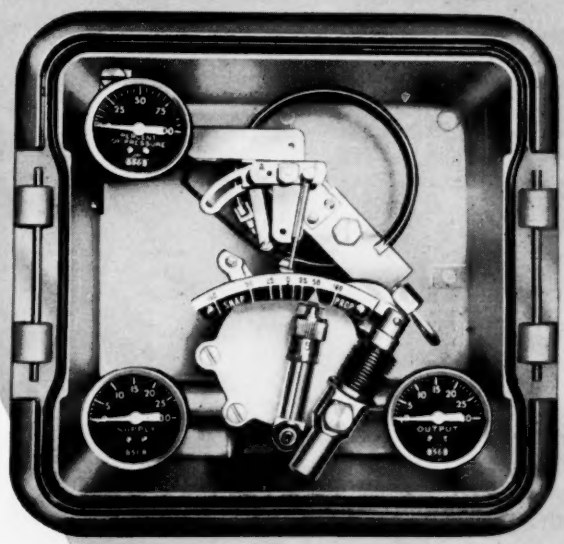
BACK PRESSURE CONTROL



LOW PRESSURE CONTROL



DIFFERENTIAL PRESSURE ...FLOW CONTROL



FEATURES OF POWER UNIT:

- Three-To-One High Capacity Relay
- Vibration Proof
- Push Button Cleanout
- Factory Calibrated Feed-Back Bellows
- Micrometer Adjustment

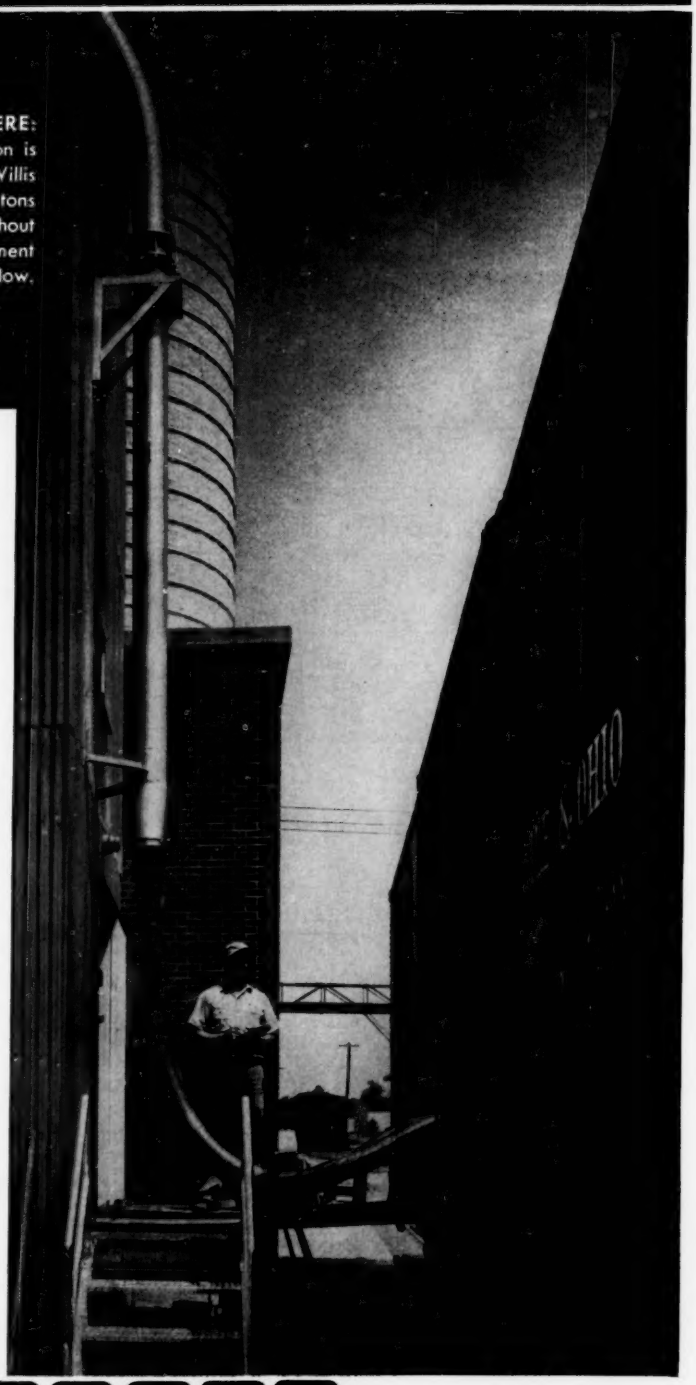
Ask Your BS&B Sales Engineer For Full Details, Or Write For Catalog 72-14.

OVER 60 YEARS BS&B RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-M3
7500 East 12th Street
Kansas City 26, Missouri

flowing air moves bulk materials better



AUTOMATIC PRODUCTION STARTS HERE: This compact Airstream Conveyor installation is at Easton (Md.) feed mill of J. McKenny Willis & Son, Inc. Self-cleaning system unloads 25 tons per hour of soft meals for animal feed without dust, waste or mixing of meals. Vertical movement requires no more power than horizontal flow.

Efficient bulk materials handling is a major factor in any modern plant. Outmoded handling methods put a costly kink in production processes which are otherwise smooth and automatic.

A Dracco Airstream Conveyor can provide air-smooth bulk handling to supplement your other up-to-date operations. Airstream systems are readily adaptable to control and any degree of automation is possible. Versatile intake devices permit unmatched mobility in unloading areas. One-man supervision, with flow regulated from a central control panel, replaces costly manual handling.

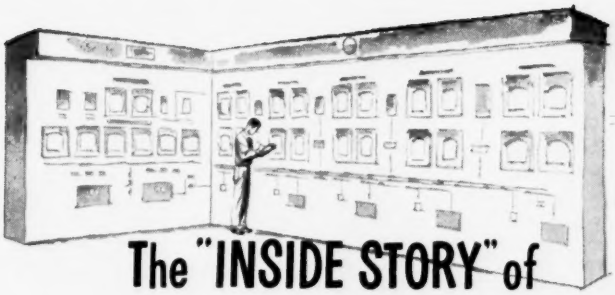
Airstream Conveyors are enclosed and self-cleaning, permitting movement of different materials in quick succession without dust, waste or intermixing. Conveying lines require little space, conform easily to existing plant layouts, can be installed out-of-the-way without expensive structural supports.

For more information on how flowing air can move your bulk materials better and cut handling costs, call or write:

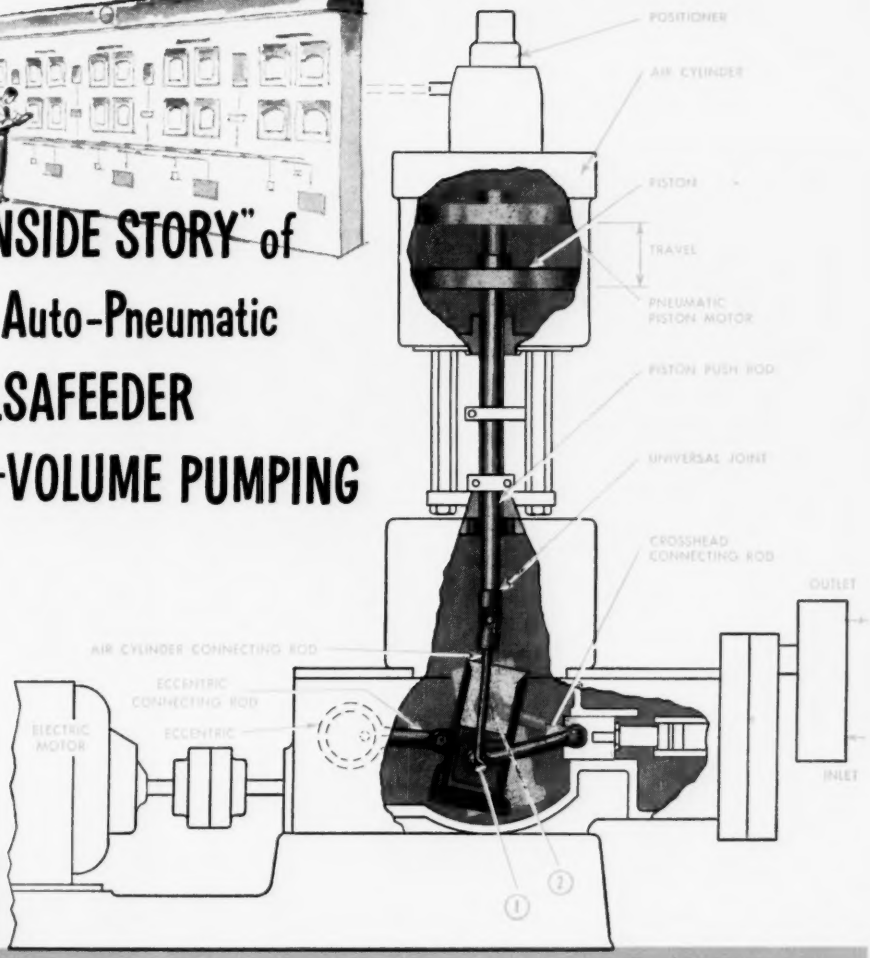
DRACCO DIVISION OF FULLER CO.
4040 East 116th Street • Cleveland 5, Ohio

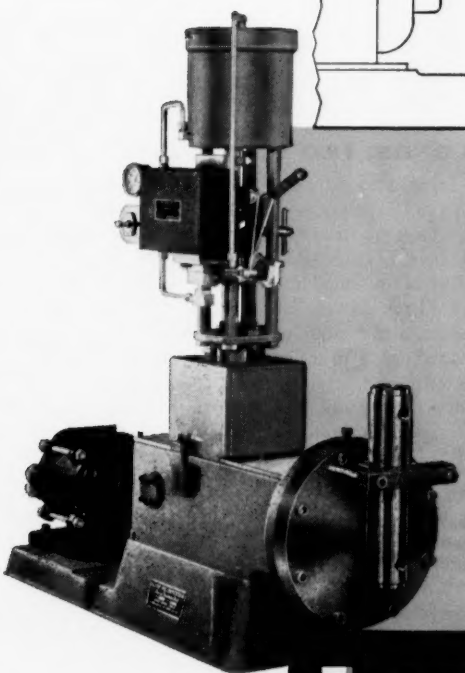
New 32-page brochure presents detailed information on how Dracco Airstream Conveyors have solved bulk materials handling problems. Write for Bulletin 530.

DRACCO *airstream* conveyors
dust control equipment



The "INSIDE STORY" of Auto-Pneumatic PULSAFEEDER CONTROLLED-VOLUME PUMPING

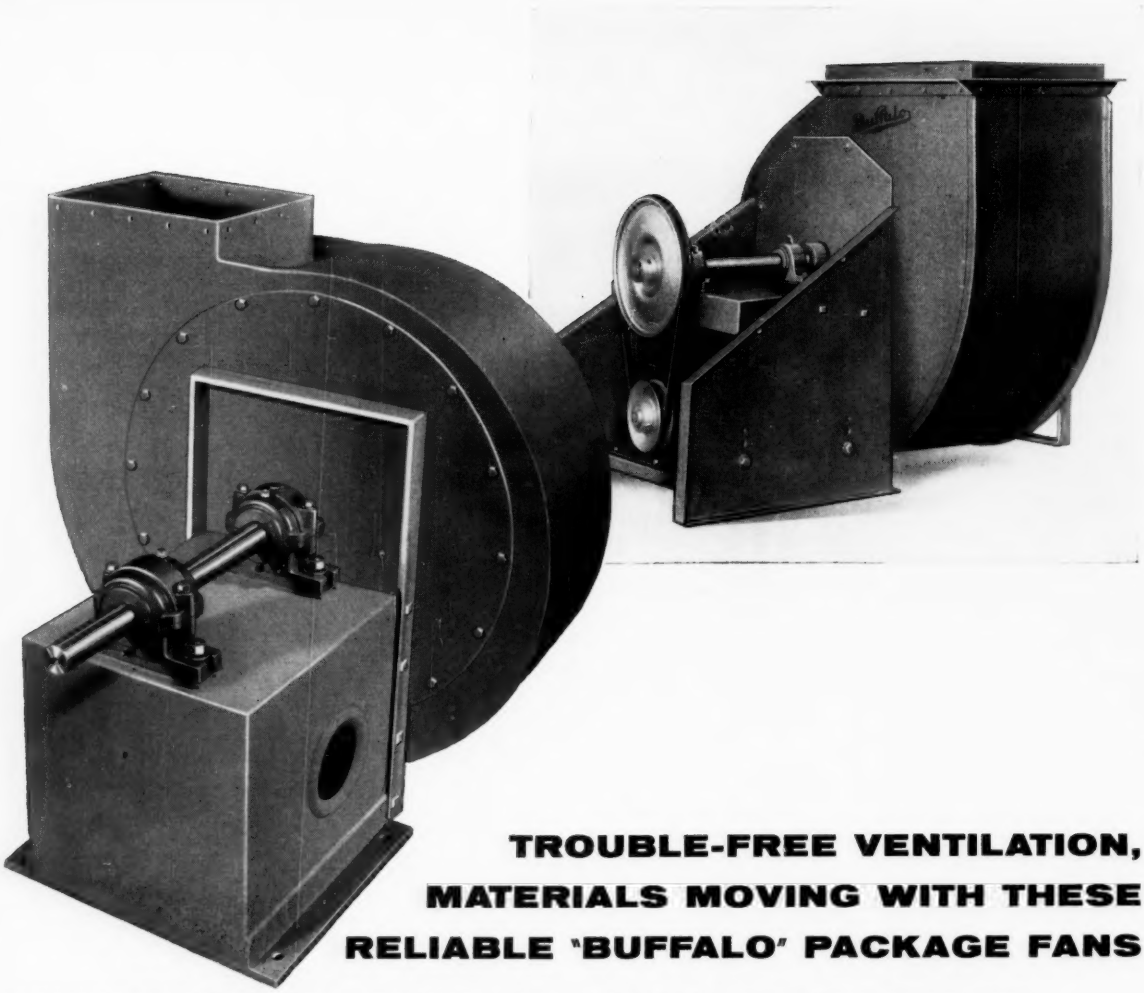




In many industrial processes, liquids must be metered in relation to some changing process condition. It can be a change in flow or pH, temperature or pressure. Instruments can sense such a change and transmit an air signal descriptive of that change. The auto-pneumatic control mounted on the Pulsafeeder pump receives and interprets this signal and automatically adjusts pump to meet the process variable. This is accomplished by a positioning device on the auto-pneumatic control that loads or unloads the air cylinder, accurately moving the air piston to position the connecting rod (1) in relation to the axis (2). This determines the stroke length of the pump—a longer stroke increases pump output; a shorter stroke reduces output. Instrument air pressure over a range of 3-15 psig. controls Pulsafeeder output from 0-100% of capacity. Ratio adjustment is available in all models.

WRITE FOR BULLETIN 440 *with typical applications, flow charts, description and specifications of both* MANUALLY CONTROLLED *and* AUTO-PNEUMATIC *models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Div., 378 Poplar St., Le Roy, N. Y.*

Lapp



TROUBLE-FREE VENTILATION, MATERIALS MOVING WITH THESE RELIABLE "BUFFALO" PACKAGE FANS

"BUFFALO" INDUSTRIAL EXHAUSTERS

"Buffalo" Industrial Exhausters are available in a wide variety of models, capacities and arrangements to handle your most demanding air or material handling jobs with the utmost efficiency and dependability. The heavy welded steel plate housing is adjustable to any desired direction of discharge. Ease of maintenance is assured by the removable front and back plates. The several arrangements in the line include both belted and direct-connected drives. The 8-bladed, all-welded air wheel effectively exhausts hot air, gases, fumes and light dust. Corrosion-resistant construction can be specified. Two types of material wheels cover all exhausting requirements, from emery dust, sawdust, paper, and chips to long shavings and other stringy substances. Capacities range from 600 to 37,000 cfm.

There's a rugged, reliable "Buffalo" Industrial Exhauster to fit most air or material handling requirements. Call in your "Buffalo" Representative, or write for full information in Bulletin 3576-B.

"BUFFALO" BELTED VENT SETS

Where low initial and operating costs are important . . . where a quiet fan is necessary . . . where a "package" unit is desirable . . . more and more industrial users are turning to "Buffalo" Belted Vent Sets. These versatile units are especially adaptable to smaller system requirements, or for use when central system ventilation requires augmentation. They offer quiet, stable performance, high efficiencies and the non-overloading characteristics of the largest "Buffalo" Fans. A lightweight package, they can be quickly and easily installed indoors, outdoors or as power roof ventilators. Available in capacities from 500 to 20,000 cfm (capacity can be modified at any time by changing motor or fan pulleys).

"Buffalo" Belted Vent Sets may be the economical answer to *your* smaller system ventilation needs. Contact your nearest "Buffalo" Engineering Representative, or write for Bulletin 3720-A.

Every "Buffalo" product features the famous "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life.

BUFFALO FORGE COMPANY

BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING · AIR CLEANING · AIR TEMPERING · INDUCED DRAFT · EXHAUSTING
FORCED DRAFT · COOLING · HEATING · PRESSURE BLOWING

By Snow Generator or By Direct Injection,
The Liquiflow CO_2 System Insures

ABSOLUTE PRODUCT TEMPERATURE CONTROL IN PULVERIZATION

- Assures the uniform refrigeration required in size reduction on chemicals, resins, plastics, pharmaceutical products, antibiotics, sugar, spices and heat sensitive products.
- Effectively inerts flammable materials during milling by lowering the oxygen concentration.
- Milling capacity is greatly increased by use of Liquiflow (liquid CO_2 system).

HOW WILL CO_2 HELP YOU MOST?

Write for free booklet "Applications Unlimited" which describes pulverization and dozens of other uses for CO_2. We will also send complete information on the Liquiflow system.

World's Largest Producer of CO_2

LIQUID CARBONIC

DIVISION OF GENERAL DYNAMICS CORPORATION

3118 S. Kedzie Avenue
Chicago 23, Illinois

No Repairs in a Full Year of Round-the-Clock Service

In the chlorinated products division of Diamond Alkali Company at Painesville, Ohio, these LaBour Type G pumps—purchased in 1948—are on continuous duty, lifting chlorinated solutions to the cooling towers above the mixing tanks. Each of the four pumps lifts about 120,000 gallons per day, to dissipate heat produced by introduction of the chlorine into the process of manufacturing chlorowax, carbon tetrachloride and anhydrous hydrochloric acid. Ten other LaBour pumps serve other divisions of the Painesville plant.

In 24-hour service atop the 15,000-gallon mixing tanks, the LaBour pumps take a beating, but they deliver the work they were bought to do. Sometimes a full year goes by without the necessity for any repairs or replacement parts. LaBour Type G is packingless, so there is never any need for servicing to prevent packing leaks.

If you are looking for this kind of dependable, low-cost service in your liquid moving operations, get in touch with LaBour.

ORIGINAL MANUFACTURERS OF THE SELF-PRIMING CENTRIFUGAL PUMP

LABOUR

THE LABOUR COMPANY, INC. — Elkhart, Indiana, U.S.A.

BECCO's high-purity Peracetic Acid is available for immediate delivery!

Seems that there are still a few people who don't know they can get immediate delivery on high-purity Peracetic Acid. Fact is, commercial quantities of Becco's Peracetic are available right now, in a solution of the following typical composition—uncontaminated with any other organic material:

CH_3COOOH. . . 40% CH_3COOH. . . 39%
H_2SO_4. . . . 1% H_2O. . . . 15% H_2O_2. . . . 5%
(Plus a stabilizer, 500 ppm)

Becco research has studied many epoxidation techniques and stands ready now, as always, to help you use high-purity Peracetic Acid to meet your particular epoxidation requirements. For example, under reaction conditions developed by Becco, high yields of epoxides are obtainable from a wide variety of difficult-to-epoxidize olefinics.

Moreover, this versatile oxidant has proved superior in the production of amine oxides, sulfones, metal salts, etc. Becco Peracetic Acid is also widely used as a bleaching agent, as a germicide, and as a polymerization catalyst.

The essential points to remember are these: If you are currently using Peracetic Acid, rely on Becco as *the* source for the *high-purity* product. If you are not now using Peracetic, but would like to investigate its use in epoxidation reactions (or the use of H_2O_2, for that matter), Becco research will work with you—and there's no obligation on your part. Feel free to consult us.

In the meantime, you will find the following bulletins of interest—they're free at your request:

BULLETIN No. 4 — Peracetic Acid 40%

BULLETIN No. 69 — Epoxidation and Hydroxylation with Becco Hydrogen Peroxide and Peracetic Acid.

Progress in Peroxygens

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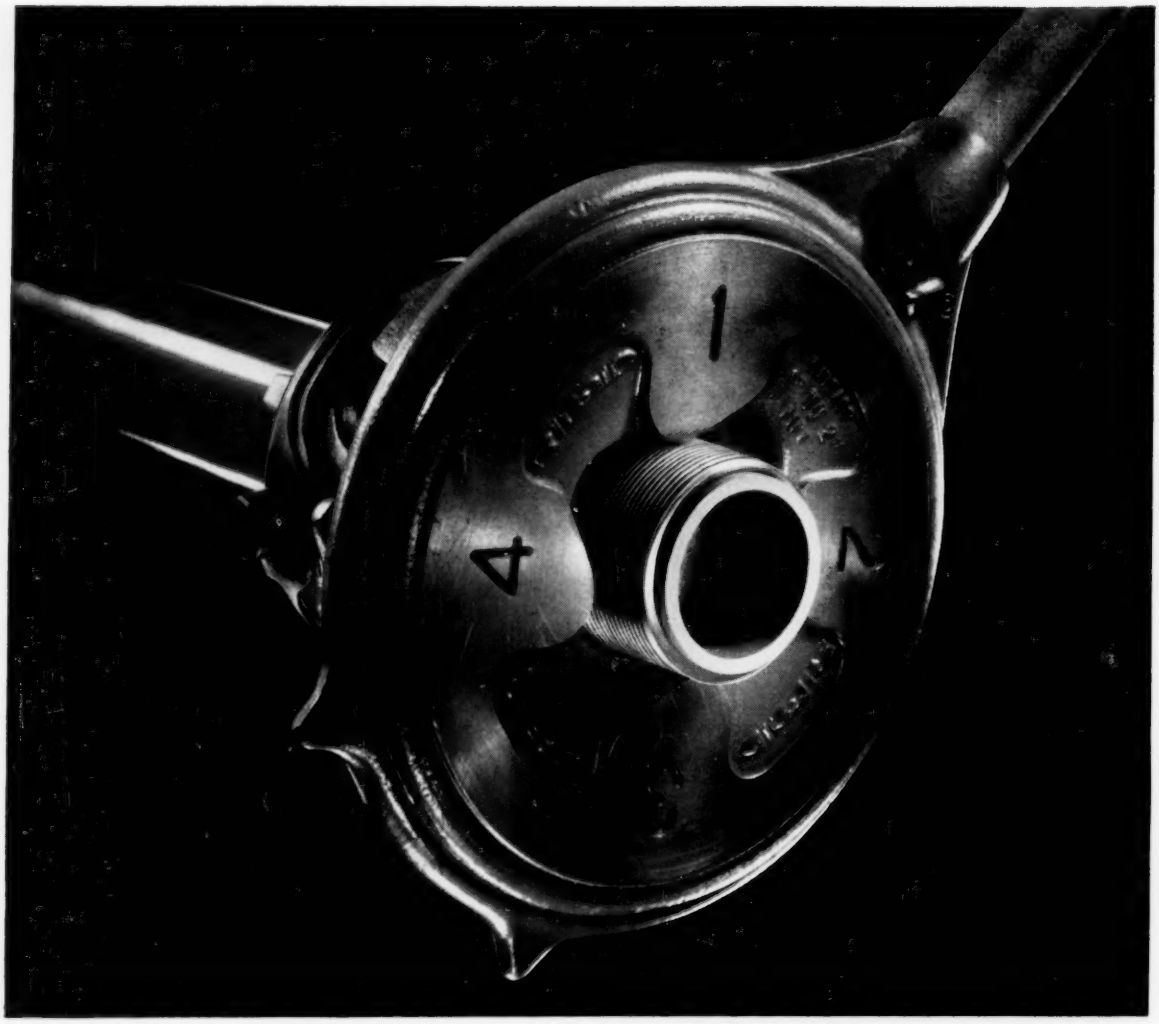
BECCO CHEMICAL DIVISION • Food Machinery and Chemical Corporation
Station B, Buffalo 7, New York

fmc
FOOD MACHINERY AND CHEMICAL CORPORATION

FMC CHEMICALS INCLUDE: **BECCO** Peroxygen Chemicals • **WESTVACO** Phosphates, Barium and Magnesium Chemicals • **WESTVACO** Alkalis, Chlorinated Chemicals and Carbon Bisulfide • **NIAGARA** Insecticides, Fungicides and Industrial Sulphur • **OHIO-APEX** Plasticizers and Chemicals • **FAIRFIELD** Pesticide Compounds and Organic Chemicals



Here's why saran lined pipe cuts installation costs

It's easy to fabricate, easy to install at job site . . .
and it resists corrosion for years

Here is a corrosion-resistant pipe that can be fabricated in the field. Saran lined pipe can be cut and threaded at the job site with conventional hand tools or power equipment. And, once installed, saran lined piping systems resist corrosion for years . . . offering proved long-range economy.

For piping acids, alkalies, solvents and other corrosive fluids specify saran lined pipe, fittings, valves, and pumps with the new gray lining. This new lining anchored under pressure within the steel casing, enables you to pipe fluids over a wider range of temperatures than ever before . . . with maximum protection from corrosion, plus the strength of steel.

Saran lined pipe, fittings, valves, and pumps are available for systems operating from vacuum to 300 psi, and from well below zero to 200°F.

If your operation can benefit from a *complete* corrosion resistant piping system, write today for more information about saran lined piping components. And be sure to ask about Saraloy® 898 tank lining, too! THE DOW CHEMICAL COMPANY, Midland, Michigan.

SARAN LINED PIPE COMPANY
DEPT. 2001A
2415 BURDETTE AVENUE
FERNDALE 20, MICHIGAN

Please send me information on: ☐ Saran lined pipe, fittings and valves. ☐ Saran lined centrifugal pumps. ☐ Saraloy 898 chemical resistant sheeting.

Name_____ Title_____ Company_____

Address_____ City_____ State_____

YOU CAN DEPEND ON DOW

NEW! direct tank-mounted LIQUID LEVEL TRANSMITTER

Exclusive static pressure connection for closed vessels above or below atmosphere . . . eliminates need for second instrument.

This sensing diaphragm capsule flange-mounts directly on side of tank. All wetted parts of Type 316 stainless steel, with optional plastic coating for further corrosion protection.

with DIRECT 3-15 psi air output signal

IDEAL FOR: Viscous or corrosive fluids, slurries, and solids-in-suspension, as well as "easy-to-measure" fluids.

Now you can measure the level of "difficult" or easy-to-measure fluids — economically, without the complication of floats or bubble tubes, and with *sustained high accuracy over the entire range span.*

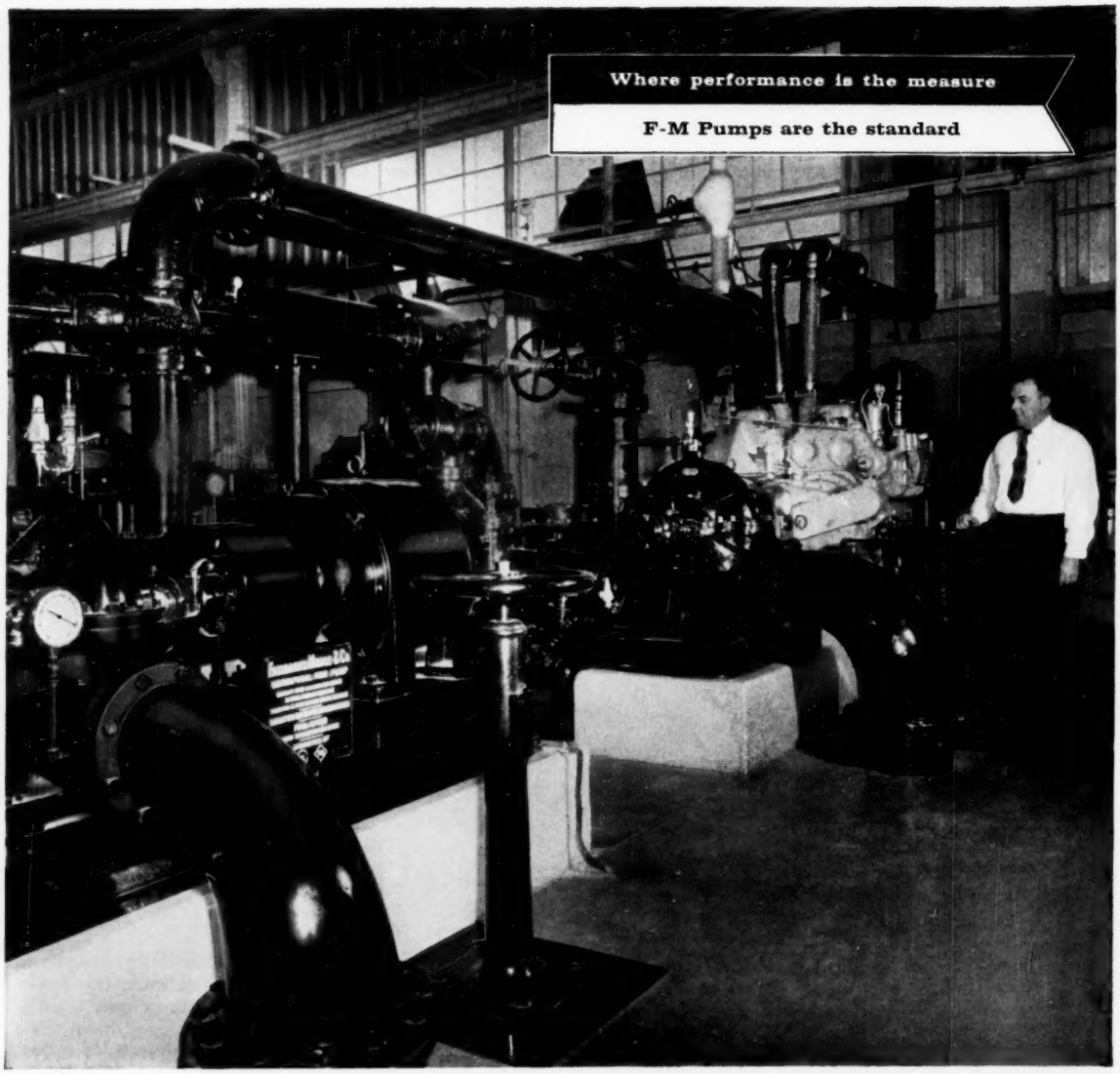
Flange-mounted directly to the side of an open or closed tank, the Type 13FA Transmitter eliminates piping and purging. Its stainless steel diaphragm capsule senses level changes instantly. Conventional tubing leads its output air signal directly to standard 3-15 psi receiver-recorders and controllers without need for intermediate signal converters.

The 13FA provides an accurate, trouble-free solution for level measurement problems. Write for detailed information, or ask your nearby Foxboro Field Engineer to explain its application to your specific process. **The Foxboro Company, 363 Neponset Ave., Foxboro, Mass., U.S.A.**

FOXBORO

REG. U.S. PAT. OFF.

LIQUID LEVEL TRANSMITTERS



Mr. George Biggar, plant engineer of Ford Motor Company assembly plant at Mahwah, N. J., checks Fairbanks-Morse fire pumps (1500 gpm. motor-driven pump in foreground, 2500 gpm. diesel-driven pump near Mr. Biggar).

Ford guards against fire at giant new plant

To protect one of the world's largest auto assembly plants against fire, Ford Motor Company depends on these two Fairbanks-Morse fire pumps. As the heart of an extensive system, the two F-M pumps provide defense in depth, one pump backstopping the other.

This installation is typical of the great care and planning by modern industry to prevent the catastrophe of fire. Call in your F-M Sales Engineer for expert assistance in pump specification. As builder of the world's greatest variety of hydraulic combinations, Fairbanks-Morse will provide the exact type, exact size pump you need for maximum dependability.

For information write Fairbanks, Morse & Co., Dept. CE-3-10, 600 S. Michigan Ave., Chicago 5, Ill.

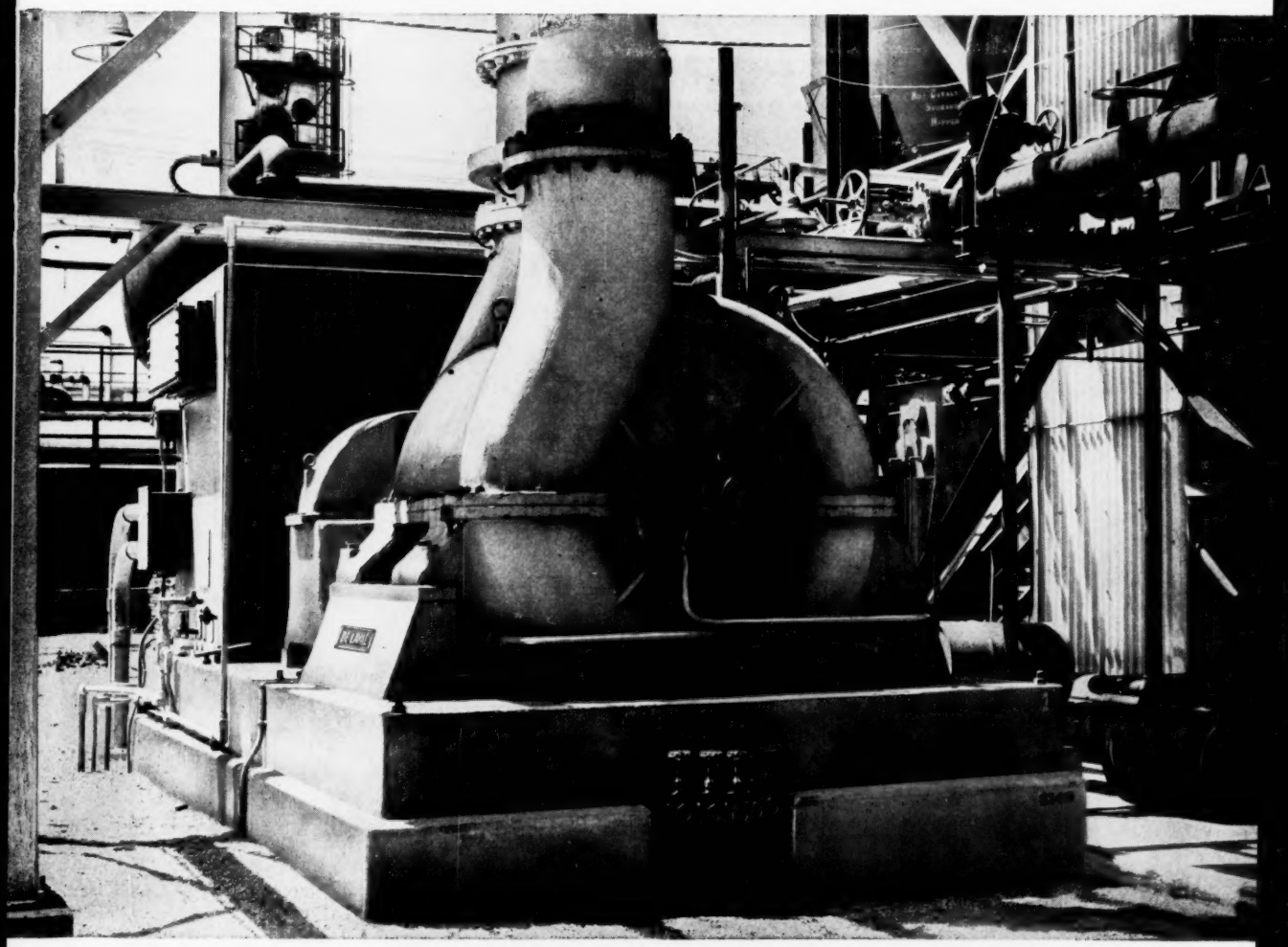
Ask for F-M Fire Pump Bulletins 5814F (horizontal) and 6920F (vertical).

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS

Another **DE LAVAL** *combustion air compressor dependably serves refinery cat cracker*



On stream at the Coffeyville, Kansas plant of the Cooperative Refinery Association, this De Laval Centrifugal Compressor delivers 24,100 cfm of air. Inlet pressure is 14.0 psia, discharge pressure 38.9 psia. Compressor output is controlled with adjustable inlet guide vanes.

This De Laval main air compressor is driven by a 2500 hp, 1800 rpm motor. Shaft speed is increased to 4800 rpm through a De Laval double helical speed increasing gear.

Cooperative Refinery Association is only one of many refiners who have specified De Laval Compressors. Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylation, coking or any similar service, it pays to look to De Laval. Rugged De Laval centrifugal compressors perform dependably in heavy-duty continuous operation. De Laval has more than 40 years of experience in solving gas compression problems.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY
803 Nottingham Way, Trenton 2, New Jersey

01.303

A new TYGON TANK LINING

- dense, extruded body
- non-oxidizing—for long service life
- excellent chemical resistance —particularly to chromic and other oxidizing acids
- negligible extractibility
- high electrical resistivity
- tough, abrasion-resistant

This new Tygon tank lining material (Formulation 105A) represents a major step forward in the development of plastic linings for corrosive service. This new lining is *extruded*, not calendered. It is completely free of laminations, hence no "peeling" in service. It shows excellent resistance to highly oxidizing acids, including chromic.

103-F

Tygon Tank Linings can be installed at our plant or in the plants of licensed fabricators throughout the United States and Canada. Write today for Bulletin TL-526R.

U. S. STONEWARE
AKRON 9, OHIO

Chemical Engineering

Developments

MARCH 10, 1958

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After a disastrous explosion 76

Monsanto is still in the parathion business. In fact, the firm built a major new unit at a site closer to markets and to a source of two essential process reagents.

To speed up sugar decolorizing 80

Capitalizing on a rugged adsorbent, Industrial Sugars, Inc., has reworked the pivotal color-removal step in its refinery. Here are the newsworthy process "firsts."

Now, stretchable, shock-resistant paper 84

The same fertile brain that gave the world dimensionally stable Sanforized cotton has just come up with a process for highly flexible, tough, extensible paper.

Output of aryl mercaptans may soar 88

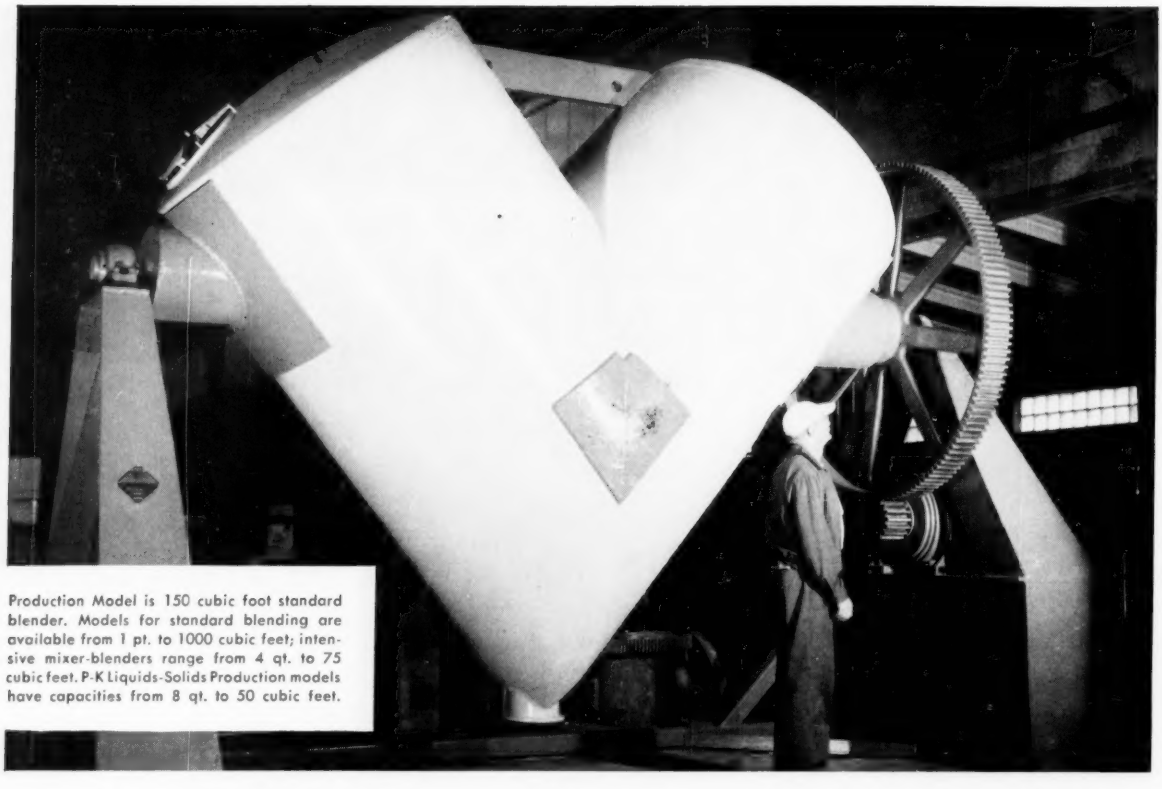
Pitt-Consol hopes to quadruple output of aryl mercaptans by grafting a sludge-using unit to its cresylic acid refinery. Price of mercaptans may be cut in half.

Ultrasonic agitator whips it up 94

New fields of application—from peanut butter to high-octane gasoline—are uncovered almost daily for these super-homogenizers. Cost is only 20% of usual outlay.

High-purity silicon market: Shrinks as it grows 102

Silicon's future is very rosy. Unquestionably so. But, producers of high-purity silicon had better watch out for booby traps; tomorrow, a pound may go further.



Production Model is 150 cubic foot standard blender. Models for standard blending are available from 1 pt. to 1000 cubic feet; intensive mixer-blenders range from 4 qt. to 75 cubic feet. P-K Liquids-Solids Production models have capacities from 8 qt. to 50 cubic feet.

Production Results Prove Superiority of P-K's New Blending Concept

Leading companies in virtually all the chemical and process industries have found that P-K "Twin-Shell" blenders have met their blending requirements better . . . faster . . . and more economically than conventional mixer-blenders.

P-K makes 3 types of "Twin-Shell" models to meet practically all blending functions – there is a production model for standard precision blending, a model for *intensive* mixing-blending, a model where exact quantities of liquids are introduced and intimately blended into dry solids.

These models are all based on P-K's radically different "Twin-Shell" blending concept which has a proven mechanical advantage that pays off in fast, consistently uniform blends . . . dust-free, moisture-proof operation . . . and quick, easy discharging.

The fundamental "Twin-Shell" mixing principle combines a gentle rolling, folding and dividing action within the entire mass of material to create a rapid and uniform blending of formulations regardless of varying particle size, shape or density. Furthermore, the smooth, interior of the "Twin-Shell" blender shape affords complete accessibility for fast, easy cleaning – quick changeover for new formulations without fear of contamination.

Prove these benefits yourself at P-K's Customer Service Lab

P-K can help you to determine accurately the right type of "Twin-Shell" blender for your needs. Complete lab facilities are available for blending materials from 4 qts. to 3 cubic feet (working capacities) – comparison tests can be made on the spot. You and your staff can conduct your own blending studies . . . or you can utilize P-K's qualified blender technicians to assist you in product research. This service is available without obligation because P-K recognizes that more and more companies realize the importance of pre-testing before purchase – they realize too, the need to keep their present blending methods up-to-date. If it is impossible for you to conduct these tests personally, arrangements can be made for you to send us your formulations for testing. In either case, contact Russell Dotter at P-K.

For technical data on P-K "Twin-Shell" blenders for production or laboratory use, write for bulletins 15a-1 (lab) or 15 (production). The Patterson-Kelley Co., Inc., 1503 Hanson Street, East Stroudsburg, Pa. Phone: Stroudsburg 820.

All P-K "Twin-Shell" blenders are patented and the name registered.

15

Patterson Kelley

Chemical and Process Division

P-K "Twin-Shell" Blenders • Heat Exchangers • Packaged Pilot Plants • P-K Lever-Lock Doors • P-K Vacuum Dryer Blenders

DEVELOPMENTS . . .

MARCH 10, 1958

Chementator

C. H. CHILTON

√ **Min-K, Johns-Manville's new thermal insulation, is aimed primarily at the aviation market — jet planes, missiles and rockets. J-M claims Min-K's superior properties will be vitally important in U. S. rocket and missile program.**

√ **Union Carbide has slapped a company-wide temporary moratorium on all salary hikes, along with deferral of certain expansion plans, pending analysis of business conditions. With stockholders getting usual dividends and unionized employees getting scheduled increases, morale of Carbide engineers has taken a nosedive.**

√ **Moving-bed ion exchange (e.g., Higgins, Porter, Techmanix processes) will get a big boost from uranium producers. At least five mills in Canada and two in U. S. plan to use such systems.**

Shale oil: Solid gains, more problems

There was justifiable pride in Union Oil Co.'s disclosure last month at the National Western Mining Conference in Denver that the Navy is now evaluating Union's first barrel-lot samples of jet fuel and marine diesel oil produced from Colorado oil shale.

Union's Fred Hartley also revealed that cost of operating the prototype retort at Parachute Creek (*Chem. Eng.*, Sept. 1957, pp. 146-8) had dropped below the original goal of $1/bbl. New target: 50¢/bbl.

Retort has run continuously for periods up to six weeks, has greatly exceeded reported design rate (900 tons/day vs. 360 tons/day). Oil yields range from 21 to 28 gal./ton of rock, varying with richness of feed rather than rate of throughput.

Despite such solid technological gains, Union spokesmen continue to plug for government tax depletion allowances equivalent to those now allowed producers of petroleum and natural gas. Among the remaining apparent obstacles to commercial shale oil are these:

• Out of 6 million Btu. recovered from 1 ton of shale, approximately 2 million Btu. is in the noncondensable gas fraction. Publicly, Union has indicated little about how this big fraction will be utilized other than to say that it can be used for producing process steam and heat and as local power plant fuel.

• Sizable quantities of coke and ammonium sulfate byproducts result from refining of raw shale oil. These must be disposed of economically.

Cows, sheep thrive on urea cocktails

Addition of ethyl alcohol and phosphoric acid to urea-containing cattle feed may help break open this huge potential outlet for urea.

Liquid feed compositions incorporating these ingredients have been developed and recently patented (U. S. 2,808,332) by Feed Service Corp., Crete, Nebr., and bear the trade name "Morea." A typical Morea feed contains

(Continued on page 72)

fluidized techniques for SO_2 production in West Germany

The first installation in Germany of a Dorrco FluoSolids system for the production of SO_2 gas from pyrites recently went on stream in a large chemical plant. Main component of the system is the 7-foot diameter Dorrco FluoSolids Reactor in which 36 tons per day of pyrite containing 43% Sulfur is roasted at 900°C, delivering 10,000 CFM of SO_2 gas for the manufacture of 50 tons per day of 98% H_2SO_4.

Today, commercial applications of the Dorrco FluoSolids system for pyrite and pyrrhotites roasting total 52 reactors in 33 installations located in 12 countries. These units cumulatively produce the SO_2 gas necessary for the manufacture of over 5,000 tons per day of sulfuric acid . . . dramatic evidence of the world-wide acceptance of this most significant advance in roasting techniques in the last 35 years.

If there is a step in your flowsheet where intimate contact between solids and gases is essential, fluidization should be investigated. Dorr-Oliver research, design and engineering staffs in collaboration with our associated companies and representatives throughout the world can work to your advantage.

For complete information write Dorr-Oliver Incorporated, Stamford, Connecticut.

Dorrco and FluoSolids are Trademarks of Dorr-Oliver Inc., Reg. U. S. Pat. Off.

DORR-OLIVER
INCORPORATED
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
STAMFORD • CONNECTICUT • U. S. A.

67% molasses, 10% urea, 6% alcohol and 3% phosphoric acid, plus minor ingredients.

Feed Service Corp. produces a premix which contains all ingredients except molasses. (Allied's Omaha plant supplies the urea in solution form.) FSC sells the premix to feed manufacturers, who combine it with molasses to make the final product and deliver it to cattle and sheep feeders.

To date FSC has lined up about 40 mixer-distributors in the Midwest and has licensed U. S. Industrial Chemicals Co. to produce and sell Morea east of the Mississippi and west of the Continental Divide. FSC foresees a network of 1,000 mixer-distributors across the country within the next few years.

Feed Service Corp. was formed in 1951 especially for the purpose of developing a feed industry based on non-protein nitrogen. It was soon apparent that two problems had to be solved if urea were going to replace oilseed meals as a nitrogen source for ruminants:

- Urea's potential toxicity had to be fully understood and controlled.
- Insufficient palatability of urea-containing feeds had to be understood and improved.

First problem was solved by addition of phosphoric acid to keep pH of the rumen contents below 7.2. This prevents formation of the real toxic culprit, oxalic acid, says FSC.

Palatability, says FSC, is a function of rate of metabolism which, in turn, depends to a large extent on oxidation-reduction potential in the rumen. O-R potential should ideally be between −0.4 and −0.2 volts. Microbial action on the alcohol in the feed liberates hydrogen to achieve the desired potential.

Morea selling prices are comparable to vegetable protein supplements. FSC claims that Morea-fed animals are ready for market earlier, that the carcasses have less waste fat and yield a more tender meat.

MTC yields char for Western markets

Koal Krudes, Inc., has just started trial runs of its new $300,000 medium-temperature coal carbonization plant at Red Lodge, Mont. Koal Krudes' process, first of its kind in the U. S., may offer a much-needed tie-line between the area's abundant supply of bituminous coals and its ready market for soft, high-carbon char.

Initial trial-run char shipments go to Victor Chemical Co., Silver Bow, Mont., for reduction of phosphate rock via electric furnace, and to American Smelting & Refining, East Helena, Mont., for lead smelting.

Plant's six retorts, one of which is now in operation, were designed to handle an output of 100,000 tons/yr. of char plus distillation products. Input: about 320 tons/day of coal.

Process is continuous, whereas conventional methods are batch. Carbonization temperatures of around 1,200 F. are relatively low for a process which emphasizes carbon output (1,500-2,000 F. for standard slot-type ovens), high for chemicals-oriented processes (usually below 1,000 F.). Process has been in pilot plant for the past three years at Bozeman, Mont. (*Chem. Eng.*, July 1956, p. 138).

Aeration turbines help lick pollution

If you can't eliminate the BOD of the effluent your plant discharges to the river, you might try aerating the stream to increase its capacity for accepting the polluting wastes.

Six paper mills in Wisconsin are experimenting with this approach to the problem of pollution control. Their new-found technique: Bleed air into the water while it passes through power-generating turbines.

Marathon Div., American Can Co., put four of its seven hydro turbines at Rothschild, Wis., into the aeration business last summer when warm water and low flows depleted the normal oxygen content of the Wisconsin River. The turbines whipped a minimum of 12,000 lb./day of sorely needed oxygen into the river. Marathon's cost, as reported to TAPPI last month: 2 to 9% lower output of electrical power from the turbines. Marathon considers this expense "low enough to be economically supportable."

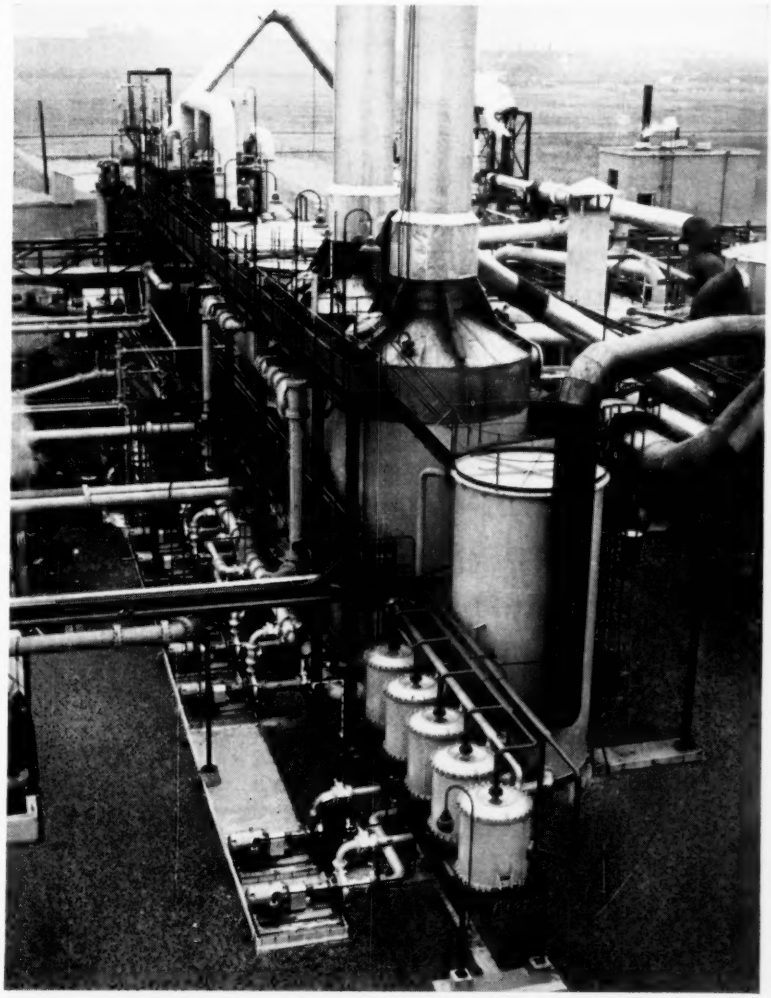
Marathon's test work showed that the most important single factor affecting the amount of oxygen picked up by turbine aeration is the oxygen level of the incoming water. As much as 2 ppm. of oxygen can be added to the water.

Yet to be determined is the possibility that bleeding air into turbines would cause cavitation, with resulting erosion. Designing aeration facilities into the original equipment might avoid such problems. Consulting Engineer B. C. Lueders and Flambeau Paper Co. are said to be working with Allis-Chalmers along these lines.

(Continued on page 74)

NOW ON STREAM...

General Chemical's newest sulfuric acid plant...*Elizabeth, New Jersey*



Shipments are now going out by rail, truck and barge from General Chemical's newest sulfuric acid plant, at Elizabeth, New Jersey. Serving northern New Jersey, metropolitan New York and New England, this plant is the 21st in General's coast-to-coast chain of sulfuric acid producing locations in this country and Canada.*

Recovering Spent Acids

Included are the most modern facilities for decomposition and regeneration of by-product spent acids. Together with similar facilities at North Claymont, Del., these make General Chemical the *only* company in the metropolitan New York and Philadelphia areas geared to recover virtually all forms of spent acids and sludges from such industries as oil refining, detergent and chemical manufacture.

For information on how this plant can serve you, write or phone nearest office listed below.

**The Nichols Chemical Company, Limited.*

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HAnover 2-7300 Ex. 222	WAlnut 2-1234	DExter 1-2366	EDison 4-9419

Among other current developments aimed at pollution control by improved aeration of the receiving body of water:

• Consultant Thomas Riddick reports that his aerator-circulator (*Chem. Eng.*, Mar. 1957, pp. 162-4) is set to go in its first industrial application, at Eli Lilly's Lafayette, Ind., plant.

• Prof. S. A. Zieminski of University of Maine described his new rotary aerator at last month's meeting of National Council for Stream Improvement. This device, which uses a submersible motor to drive a mechanical air disperser, is still in the development stage but, says Zieminski, will soon be ready for commercialization.

This pilot plant will run itself

Ever spend days or weeks hooking up pilot-plant equipment? Then more days and weeks—maybe nights and Sundays, too—running the unit and analyzing the data? If so, you're a typical chemical engineer of today's generation.

Tomorrow's chemical engineer may be more fortunate. An automatic, computer-controlled pilot plant being built by Consolidated Electrodynamics Corp. for Esso Research & Engineering may spawn a whole new breed of experimental apparatus. Upon delivery a few months from now Esso will put the cabinet-size unit to work evaluating Powerforming catalysts.

Esso engineers will feed in initial instructions; the rest is automatic. Each run will include pressure test for leaks, oil on stream, catalyst regeneration and treating. Temperatures, pressures and compositions will be monitored, controlled and printed out by electric typewriter.

The unit incorporates seven automatic analyzers—three vapor-liquid partition chromatographs, paramagnetic oxygen analyzer, thermal conductivity analyzer, infrared analyzer and moisture analyzer. With composition changes followed automatically, the length of run can be minimized, since the unit need operate at any set of conditions only long enough to reach equilibrium.

Esso expects to justify its $250,000 investment in the automatic pilot plant on the basis of these advantages:

• *Savings in time*—Complete exploration of process variables in a test program will take weeks instead of months. Esso figures that a savings of one month might be worth as much as $250,000 in some cases.

• *Savings in manpower*—Automatic programing and analysis of results will eliminate tedium and utilize engineers at their highest efficiency.

• *Increased accuracy*—Highly refined controls will decrease experimental error. A 30% reduction would cut the number of runs in half and still give information of present-day accuracy.

Next, chemical upgrading of ores

Chemical processing of uranium ore will be done in semiportable plants located at the mine, predicted Clement Chase of Techmanix Corp. at the National Western Mining Conference in Denver last month.

Such plants would produce a loaded ion exchange resin bead, a loaded solvent, a pregnant eluate or a uranium syrup. The upgraded uranium-bearing product—containing 1 to 5% U_3O_8—would be trucked at low cost to a large, central mill equipped with facilities for precipitation, drying, packaging and analytical control.

This type of arrangement, says Chase, would solve a number of present and anticipated problems. For example:

• The small miner would have an outlet for his ore. Processing of as little as 100 tons/day would be economical. Recently improved processing techniques would require a total plant investment of less than $200,000 for 100 tons/day capacity.

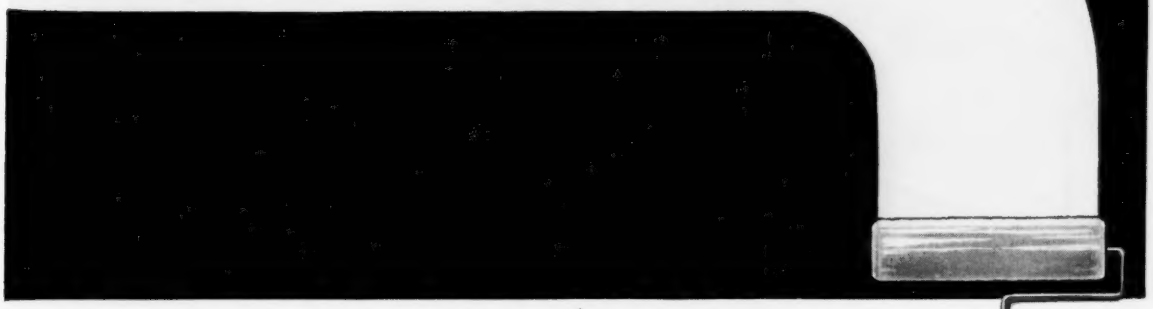
• Low-grade (e.g., 0.1% U_3O_8) and isolated ores could be processed economically, effectively increasing our workable uranium reserves. While sand-slime upgrading techniques work well for certain ores (Union Carbide Nuclear and Vanadium Corp. use this approach), they leave much to be desired in a large number of situations.

One mining company, Utco Uranium Corp, has already taken preliminary steps along these lines. Utco owns several substantial properties in northern Arizona. None of these is quite large enough to justify building a complete mill, yet there is plenty of uranium in these mines. Utco has set up a tentative agreement with one of the existing mills in its territory whereby Utco could ship to the mill a greatly enriched product.

For more on DEVELOPMENTS.....76

Where odor is a problem use these

SHELL SOLVENTS



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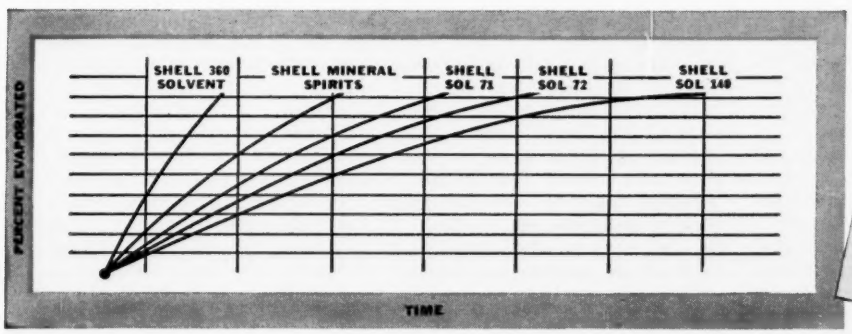
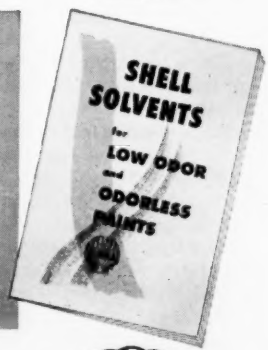
. . . traditional distillation range, solvent power and drying. Mild odor.

These solvents are recommended for low odor and odorless products.

Typical properties of these Shell Solvents are contained in booklet shown. It will be mailed on request.





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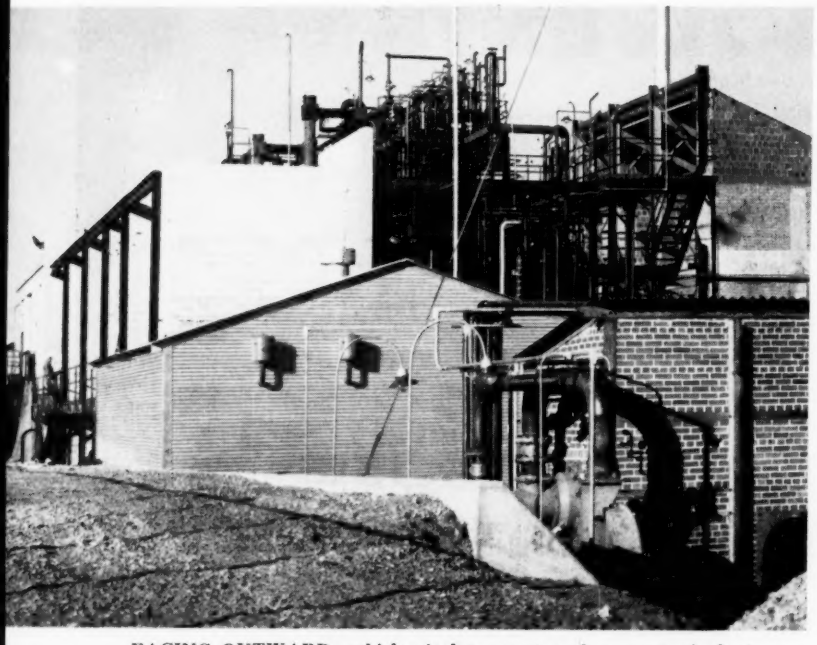
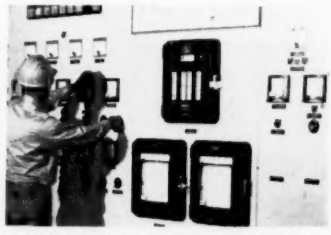
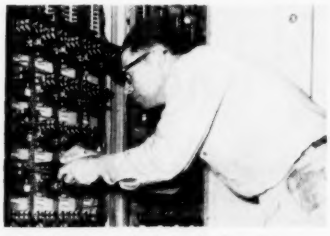


FACING OUTWARD, cubicles isolate reactors from rest of plant.

Controls Keep Vigil



ELECTRONIC recorders back up pneumatic controllers.



RELAYS and interlocks keep steps in sequence, trip alarms.

Safeguards Encircle New Insecticide Plant

Nine months from loss of its predecessor, Monsanto starts new parathion plant. Cordon of safety features will hold tricky operation under continual check.

From operating disaster to engineering triumph in nine months—that's the story of Monsanto Chemical Co.'s new plant at Anniston, Ala., for making the organophosphorus insecticides, parathion and its sister compound, methyl parathion.

Disaster was in the form of a $1-million explosion and fire at Nitro, W. Va., last April which took eight lives and destroyed Monsanto's parathion-methyl parathion plant there. With startup this January of the new Anniston facilities, Monsanto engineers, along with engineers of Catalytic Construction Co., soberly celebrated these achievements:

- Completion of construction of a major project* in only six months and ten days from beginning of design work in June.
- Relocation of parathion operations to a site closer to markets and where two essential process reagents, chlorine and caustic soda, are produced.
- Incorporation in the new unit of all possible engineering safeguards against another operating disaster.

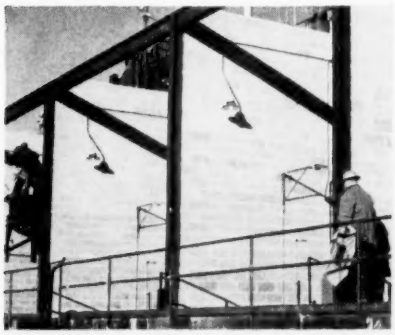
► **Emphasis on Safety**—In view of the fact that the runaway reaction at Nitro was directly attributable to an instrument failure, primary attention was given in design of the new Anniston unit to providing foolproof means for safe process control.

Parathion (chemical formula is O,O-diethyl O-*p*-nitrophenyl thiophosphate) and methyl parathion (O,O-dimethyl O-*p*-nitrophenyl thiophosphate) are made by reacting phosphorus pentasulfide with the corresponding alcohol, chlorinating the resulting ester, then condensing the chloride with the sodium salt of *p*-nitro phenol. Although raw materials and finished products are reasonably stable, some of the intermediates formed in the process are highly unstable.

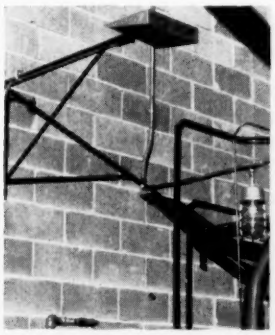
In the Nitro accident, the temperature recorder on the chlorination reactor had been giving false readings. While the instrument was being repaired on the spot—with no standby continu-

* Monsanto hasn't revealed cost or capacity of the new unit, though claiming it to be the world's largest for manufacture of parathion and methyl parathion. *CE's* own estimates: Cost, $2-3 million; capacity, 3-5 million lb./yr.

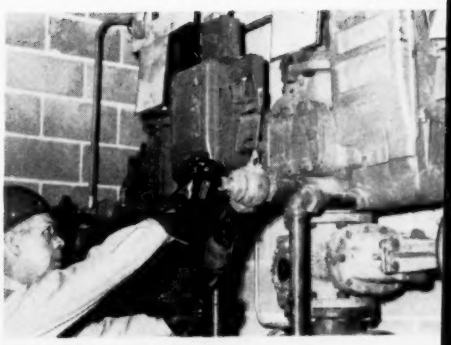
Second Line of Defense Acts if Control Breaks Down



STURDY steel-reinforced, concrete-block cubicles can direct any blast.

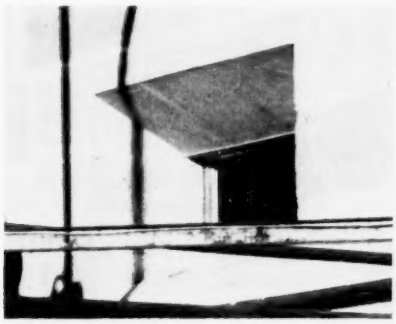


RAPID heat rise hits detector under pan, trips fog nozzles.

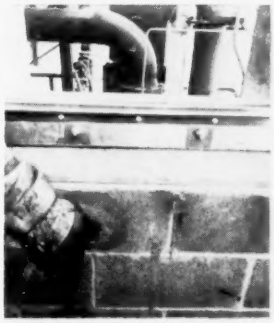


WATER for automatic deluge system runs through control center.

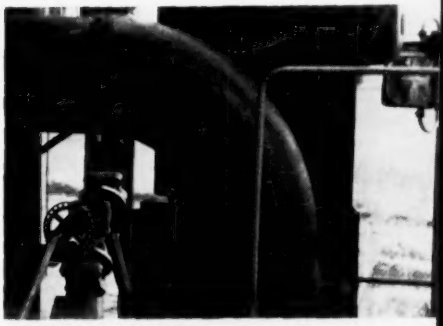
Behind Barricade, Operator Can Take Manual Action



THROUGH this explosion-proof port, operator views reactors.



USING long handle, operator regulates remote valve.



SIGHT glass in mirror, upper right, guides valve regulation, lower left.

ous monitoring of temperature—the reactor contents reached a critical temperature level and suddenly took off. First explosion ruptured the vessel itself; then flammable vapors filling the building ignited to cause a second explosion.

▶ **Keeping Tabs on Process**—In the new plant, the pneumatic recorder-controllers won't have to be repaired on the spot. They are of the miniature plug-in type which permit replacement of a defective unit with a spare in a matter of seconds.

Backing up the pneumatic temperature recorders (which get their signals from filled systems via pneumatic transmitters) are electronic indicating and recording potentiometers working from thermocouple signals wired directly into the control room. Still another safeguard is the use of field-mounted, filled-system temperature indicators at critical points in the process.

Interlocking relays prevent human errors in the complex batch processing sequence. And if the contents of any reactor reach a potentially dangerous stage, the operator can quickly open a dump valve and spill the contents into a canal charged with a neutralizing solution of soda ash or caustic soda.

▶ **Solitary Unconfinement** — Monsanto has isolated the reactors from the rest of the process area by placing them in individual cubicles. Each of the five cubicles consists of three steel-reinforced concrete block walls; fourth side and top are completely open, after the practice of the explosives industry. If anything blows, the force will be expended outward in the direction of least possible damage.

Each cubicle is provided with sprinkler heads which are actuated by rate of temperature rise. Monsanto calls it a "deluge" system, rather than a conventional sprinkler system.

Although process is normally controlled from the central instrument panel, the operator can view the reactor and its locally mounted gages through a shatterproof window. He can also operate manual valves by means of extension handles through the 12-in.-thick wall.

The rest of the plant, too, is of outdoor-type construction, so that hazards of combustible vapors will be minimized.

▶ **Death to Bugs**—Parathion and methyl parathion are two of the most powerful insecticides used in commercial agriculture. Parathion is a dark brown liquid which Monsanto sells to formulators under the trade name of Niran for $1.36/lb. (delivered in

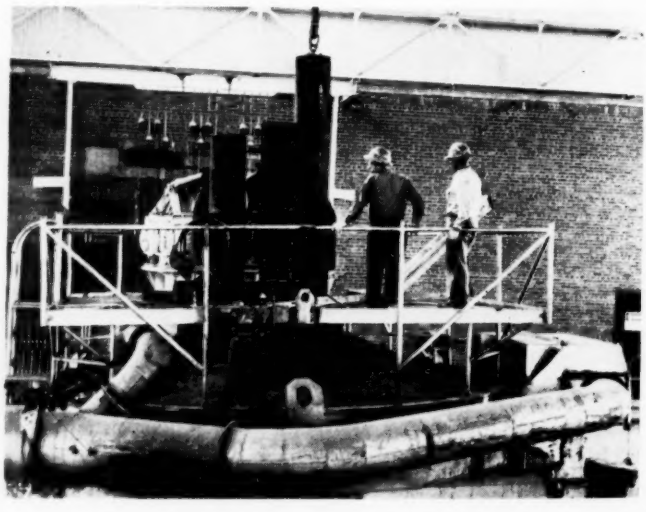
carload lots). It is a broad-spectrum insecticide, used by growers of fruits, vegetables, flowers, small grains and forage crops.

Methyl parathion, a recent commercial development (parathion came out in 1947, methyl parathion in 1954), has found enthusiastic acceptance among cotton farmers for control of the boll weevil. In some areas of the South the boll weevil has developed resistance to hydrocarbon insecticides, such as DDT and benzene hexachloride. Methyl parathion has rescued literally millions of dollars worth of cotton from destruction by "resistant" boll weevils in the past three years. Monsanto produces it as an 80% solution (the other 20% is xylene), sells the solution for $1.40/lb.

Although it costs more than parathion ($1.75/lb. of active ingredient), methyl parathion can compete for the farmer's dollar on the basis of effectiveness; Monsanto claims that it is twice as effective per lb. as parathion. It is also finding use on forage crops and small grain, particularly against aphids.

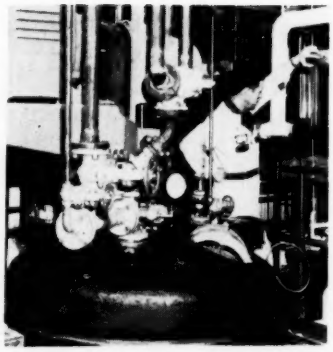
► **Handle With Care** — Either material can be formulated into sprays or dusts for application by airplane or ground machinery. Because of their high toxicity to man (compared with chlorinated hydrocarbons), these organophosphorus compounds must be handled with respect. Despite the hazards involved, there have been only widely scattered cases of human poisoning. As one farmer puts it:

"There is nothing to be scared of in methyl parathion, just a reasonable amount of caution. In safety, you've got those that don't give a damn, and those that are scared regardless of the situation. When a man reads the label, he should respect it."



Copper Flows Continuously From New Arc Furnace

A half-ton, 6-ft.-long graphite electrode is lowered into American Smelting & Refining's new copper furnace at Perth Amboy, N. J. Key to successful operation of the 30 ton/hr. unit is accurate electrode control. An air gap of ¼ to 1 in. must be maintained between the three electrodes and the shifting bath surface. Rotary regulator coupled with hydraulic servo system gives rapid response needed to control gap.



New Plant Heralds "Real" Synthetic Rubber Output

Above reactor is busily polymerizing a new type of synthetic rubber, Natsyn, at Goodyear Tire & Rubber Co.'s just-on-stream plant at Akron, Ohio.

Natsyn, says Goodyear, has molecular structure and performance characteristics of natural rubber.

Startup follows closely firm's revealing that it was using a newly developed continuous-polymerization process for high-solids latex, Pliolite, at the same site (*Chem. Eng.*, Jan. 27, 1958, p. 60).

Conferences Probe Ways To Upgrade Engineer Use

The President's Committee on Scientists and Engineers, encouraged by enthusiastic acceptance of pilot conferences, is now embarking on a more ambitious route for the first six months of 1958: up to 36 conferences in different localities to probe better ways of using scientific and technical manpower.

"As a measure of the problem", comments one spokesman, "if the U. S. could improve the use of current technical manpower supply by only 5%, it would add as much to effective professional force as an entire year's crop of college graduates."

Already 15 local groups have decided to hold conferences,* and 15 others are considering the idea.

* Los Angeles, Calif., Philadelphia, Pa., Des Moines, Iowa, Buffalo, N. Y., Knoxville, Tenn., Omaha, Neb., Lafayette, Ind., New Brunswick, N. J., Atlanta, Ga., Bozeman, Mont., Troy, N. Y., Minneapolis, Minn., East Lansing, Mich., Peoria, Ill., and Storrs, Conn.

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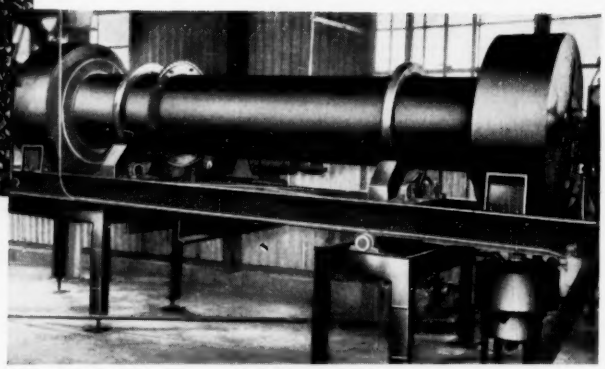
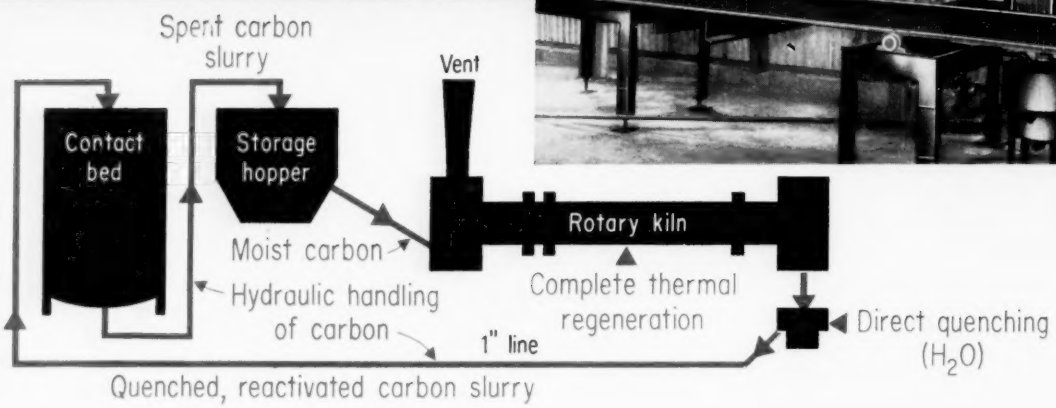
NEW DECOLORIZING PROCESS HANGS ON GRANULAR CARBON





Modern Touch Speeds Up Sugar Decolorizing

Using a tough, high-performance carbon, sugar maker's new decolorizing system operates smoother and faster.

Taking advantage of the outstanding qualities of a new-type adsorbent, Industrial Sugars, Inc., St. Louis, Mo., has reworked the pivotal color-removal step in its sugar refinery. Here are Industrial's newsworthy process "firsts":

• New adsorbent — Pittsburgh Coke & Chemical's granular activated carbon made from selected grades of bituminous coal and binder. Industrial Sugars' St. Louis plant is the first cane-sugar refinery to use granular activated carbon for virtually all its color removal.* Color loads entering the ion exchangers are now 80% lower.

• New regenerative technique — Total reactivation of granular carbon in a direct-fired, ceramic-lined rotary kiln, followed by direct water quenching. This is first regeneration of carbon by a rotary kiln.

• New handling system — Hydraulic system moves granular carbon from adsorption beds through kiln and water quench and back to contact beds. System is first or second closed carbon-handling system anywhere.

After six months of operation, Industrial Sugars has reaped three clear-cut dividends: Higher quality levels for its liquid sugar products, reduced decolorizer costs, 15% rise in plant capacity.

▶ **Others Follow Suit** — Industrial Sugars' new carbon system has been followed on stream by one in a food processing plant where PCC granular carbon replaces pulverized vegetable carbon. Other installations, complete with rotary kilns, will be on stream within the next few months.

Closed type of hydraulic circuit now handles carbon in one other plant. Some smaller installations load and unload the adsorption columns hydraulically. Corn Products' refinery at Kansas City loads columns hydraulically after receiving carbon from a Dorr-Oliver FluoSolids reactivator. Hydraulic discharge will be incorporated very shortly.

▶ **One, Two, Three**—Here's how adsorption system works, in sequence. Initially, granular activated carbon is loaded into several 9-ft.-dia. by 9½-ft.-tall columns having 15,000-lb. capacity. Raw sugar solution from defecation and pressure filtration steps passes down through the carbon beds for decolorizing before entering the ion exchange columns.

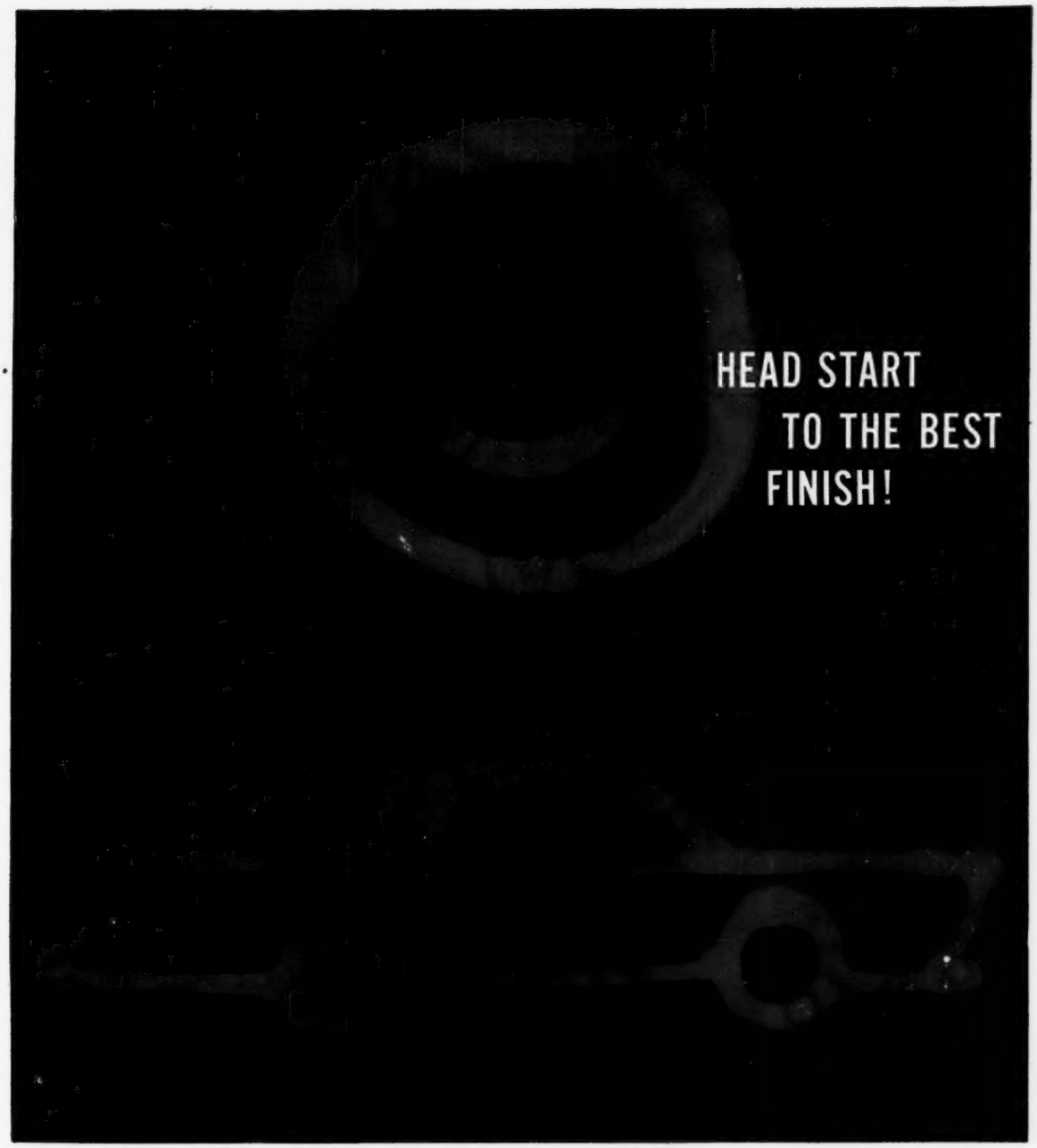
Both the granular carbon and resin beads are supported in the columns by Neva-Clog metallic filter medium.

When the granular carbon in a particular column becomes loaded with color bodies, wash water is introduced to remove residual sugar liquor. Then, air and water pressure are applied to sweep the carbon out of the column into a storage hopper where it drains. A sparger at the bottom of column removes last traces of carbon.

From storage, the spent moist carbon moves at 200-lb./hr. rate through a screw conveyor into the direct-fired rotary kiln. Regenerated carbon at 1,400 F. drops from kiln into small 12 x 12-in. quench tank to mix with 10 gpm. water. Centrifugal slurry pump pushes suspension through 1-in. black iron line leading back to empty adsorption column.

▶ **Fast and Easy** — With this closed system, Industrial Sugars handles its carbon in clean, fast, trouble-free fashion. It avoids

* For granular activated carbon's debut in corn-sugar purification, see *Chem. Eng.*, Sept. 1955, pp. 122-124.



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high labor charges, bucket elevators and other conveying equipment involved in conventional handling of dry carbon.

For example, Industrial Sugars can empty a carbon contact tower in about 40 min. with this hydraulic loop. Dry unloading of bone char towers can run up labor charges for pick and shovel work, may take up to 4 hr.

Material quenches easily in very inexpensive cooler. There's no spattering, steaming or breakdown of particles. Bone char cooling involves much more elabrate equipment.

▶**Low-Cost Calcining** — The small rotary kiln is low-cost, too —about $8,500 for Industrial Sugars' unit. For jobs handling up to 10 tons/day of carbon, this type of furnace appears more economical than alternate equipment like the Herreshoff and FluoSolids systems.

In fact, the small rotary kiln may be useful to the chemical processor with small carbon requirements who has used the material once only, rather than invest in regeneration equipment.

▶**Carbon Is Keystone** — Performance of Pittsburgh's granular activated carbon ties the whole system together.

Because of its higher adsorptive capacity, PCC's carbon increases throughput in the contact beds. Even with higher throughput, granular carbon delivers solution to the ion exchangers that contains 80% less color than is common with other systems. Not only does this boost throughput rate in the ion exchangers but it also extends resin life.

Even at the filter presses, which are removing powdered carbon used for final polishing, filtration rates are higher. And over-all there is less sweet water (washings).

In contrast to its experience with powdered carbon, Industrial Sugars finds that it can reactivate granular material completely and repeatedly with need for less than 5% makeup. Another grade of granular material tried previously wasn't hard enough to withstand thermal reactivation. And with caustic regeneration, it recouped only 40% of its original adsorptive powers.

Floating Plastic Bags To Chop Barging Costs

Floating tubular plastic bags, holding 20,000 gal. chemicals or fuel oil, that can be towed in line like a sea-going pipeline may slash barging costs by 60-80%.

In a forecast for 1958, Henry H. Reichhold, president of Reichhold Chemicals, disclosed that the company plans to use plastic bags in future for chemical shipments. And if they work out as expected, others will be sure to follow suit.

These giant bags, 100 ft. long, get buoyancy from sealed air compartments that also cushion the bag against blows and shocks. Arriving at their destination, contents can be pumped out, bags folded and shipped back inexpensively. Or, since initial cost is so small, bags could be discarded after one trip. When shipping chemicals that solidify during the trip, bags can be peeled off contents just like a sausage.

Prototypes of the plastic barges have already been demonstrated in Germany. Several different plastics can be used in fabrication, but RCI isn't saying which one will be picked until it has a manufacturer under contract.

Wood Won't Rot if Coated With Plastic

That old bugaboo of wood fabrication — rot — has met its match.

A coating of reinforced plastic applied to wood surfaces sterilizes the surface and excludes decay fungi, prevents all rot and decay. Another process plus: Plastic coating adds strength; conventional pressure treating against decay actually weakens wood.

These conclusions were reported by Richard Mark, timber engineer for Balsa Ecuador Lumber Co. of New York City, before the recent Chicago conference on reinforced plastics sponsored by the Society of the Plastics Industry. Findings were based on experiments conducted by Mark and Bert M. Zuckerman, consultant in wood pathology.

In experiments, balsa blocks covered with glass fiber mat and coated with polyester were exposed to accelerated decay conditions. Result: No measurable decay. This balsa-glass fiber-polyester combination is frequently used in "plastic" boat construction now gaining widespread acceptance.

New York City officials have already expressed interest in findings. With miles of waterfront pilings to maintain, an economical way to extend wood's usable life would chalk up real savings.

Convention Calendar

American Society of Mechanical Engineers, Lubrication Div., role of viscosity in lubrication, 150 E. 42 St., New York, N. Y., March 10-11.

Nuclear Congress and Trade Show, International Amphitheatre, Chicago, Ill., March 17-21.

National Assn. of Corrosion Engineers, national meeting, Civic Auditorium, San Francisco, Calif., March 17-21.

American Power Conference, 20th anniversary meeting, Hotel Sherman, Chicago, Ill., March 26-28.

Instrument Society of America, New Jersey Section, tenth annual symposium, Control Systems Engineering, Hotel Essex House, Newark, N. J., April 1.

American Institute of Chemical Engineers, Philadelphia-Wilmington section, all-day meeting, Scale-up in Practice, University Museum, University of Pennsylvania campus, Philadelphia, Penn., April 8.

American Welding Society, national spring meeting, in conjunction with Sixth Welding Show, Kiel Auditorium and Hotel Statler, St. Louis, Mo., April 14-18.

American Institute of Chemical Engineers, Sheraton-Mt. Royal Hotel, Montreal, Canada, April 20-23.

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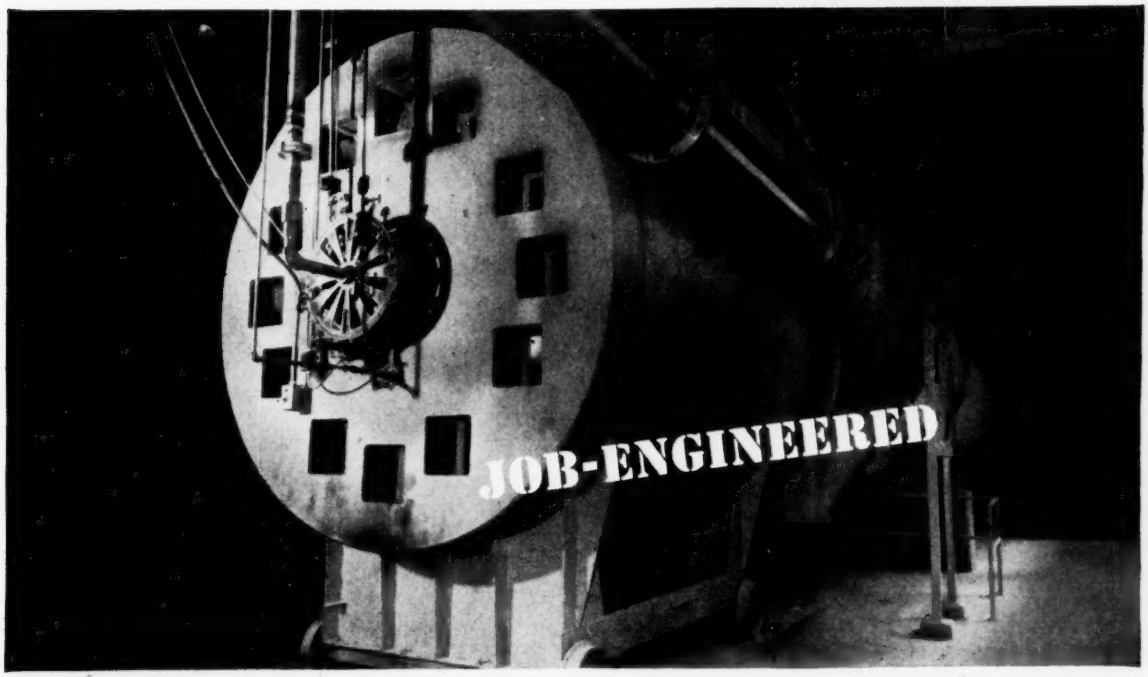
STANDARD HERSEY DRYERS



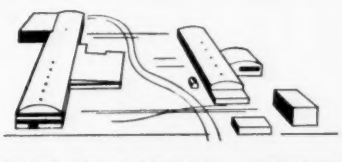
MINING FOR FOOD TO FEED THE EARTH— NEW CARLSBAD PLANT OF NATIONAL POTASH IS ON STREAM WITH STANDARD-HERSEY DRYERS!

Deep into the earth—1800 feet, deepest in the nation's potash industry—National Potash near Carlsbad, N. M., is mining for food to feed the earth, so that the earth will feed man better! Designed refinery capacity is 400,000 tons per year. And at the heart of this operation are 60-foot-long twin rotary dryers—*job engineered* Standard-Hersey dryers—designed and built by Standard Steel Corporation... a world leader in designing and manufacturing dryers, granulators, and coolers. Wide range and flexibility in Standard-Hersey dryers help you to produce almost any desired grade of fertilizer.

No matter how tough the problem, Standard Steel's *job engineering* solves it.

IF YOU HAVE A PROCESSING PROBLEM!

Standard Steel welcomes the opportunity to discuss with you any problems you may have in drying, cooling, or calcining. Our laboratory pilot testing equipment determines beforehand the best equipment for your problem.



STANDARD STEEL ACQUIRES LEADER IRON WORKS

Since Leader 1888

To meet the ever increasing needs of its world-wide customers, Standard Steel Corporation recently purchased the Leader Iron Works at Decatur, Illinois. Founded in 1888, Leader is well known for its work in the food, chemical and petroleum industries. In addition to its customary fabrication Leader will now manufacture Standard's line of heavy processing and road construction equipment.

STANDARD STEEL CORPORATION

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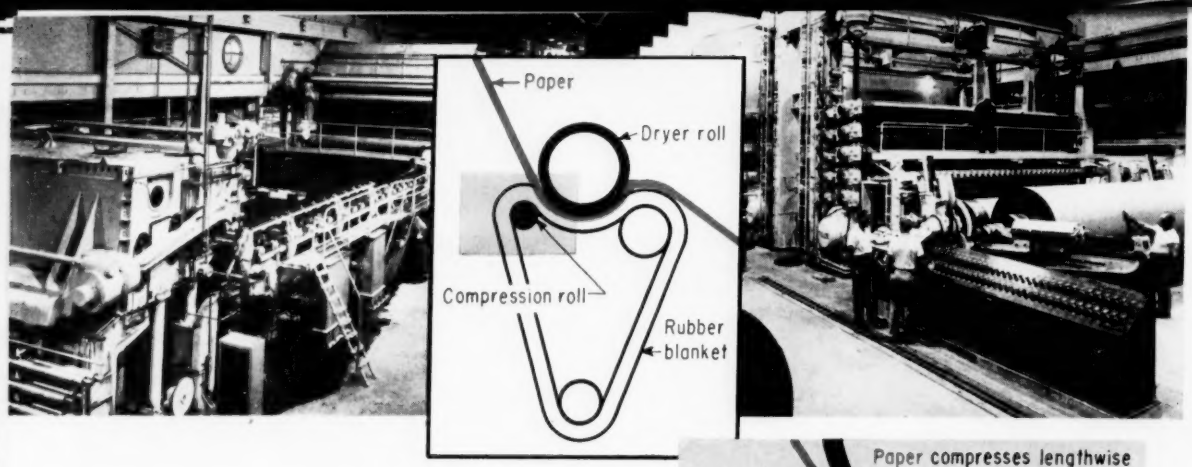
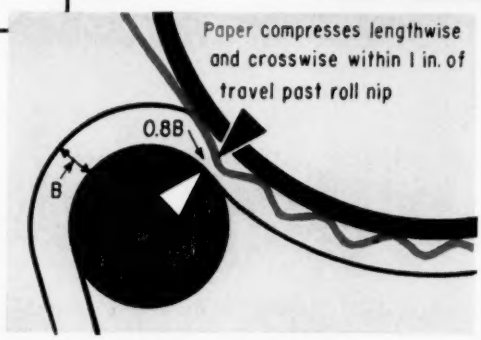
Midwest Offices & Plant **LEADER IRON WORKS** *Decatur 5, Illinois*

(Division of Standard Steel Corporation)

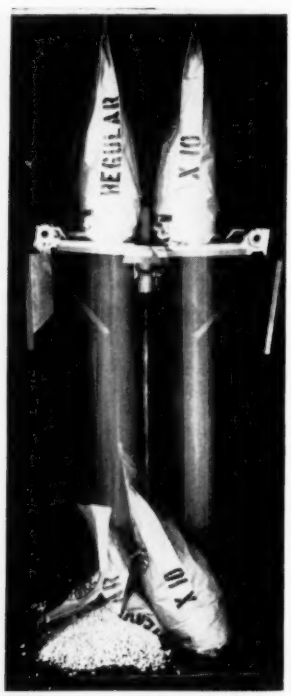
ROTARY DRYERS • KILNS • COOLERS • ASPHALT PLANTS





Deep in paper machine dryer section, compression process adds stretch that makes paper more flexible and tough.

Shrink Process Makes Paper Shock Resistant



FIVE foot drop shows how Clupak sack absorbs shock, regular sack breaks.

From the fertile brain that gave the world dimensionally stable Sanforized cotton fabrics comes now a new papermaking principle, the Clupak process. Aiming at improved shock-absorbing qualities, process makes an extensible paper that has outstanding flexibility and toughness.

Conceived by 83-yr. old Yankee inventor, Sanford Cluett, the Clupak process is now producing commercial volumes of paper on a new $25-million, 80,000 ton/yr. kraft paper machine at West Virginia Pulp & Paper Co., Charleston, S. C.

Process will be available to other paper mills under a broad licensing program to be handled through Clupak, Inc. a new corporation owned jointly by Cluett, Peabody & Co., Inc. and West Virginia Pulp & Paper Co.

▶ **Breakthrough Not Welcome**—In this age of "breakthrough" there is little sympathy for the term when it is applied to how paper sacks and bags sometimes behave. It was to overcome this shortcoming that Sanford Cluett conceived his Clupak principle.

Papermakers and their customers long have recognized that certain deficiencies in kraft paper could be reduced by increasing the paper's stretch above its present level of 2%. Then, it could absorb shock-load energy without rupturing.

To some extent, creped grades of paper can satisfy this need. However, they stretch with such comparative ease that they can absorb only a small proportion of the potential shock-load limit for paper.

Clupak paper, on the other hand, stretches grudgingly all the way to its final yield point. Thus, it absorbs large amounts of energy from the stretching force.

Appearancewise, it's hard to tell Clupak paper from regular grades of kraft. It's smooth and when you handle it there seems to be a soft quality not found in other kraft paper. Clupak paper can be printed from rolls and otherwise handled just like regular kraft.

▶ **How It Gets That Way**—What happens during the manufacture of Clupak paper to produce these

Here are the facts on peak performance, low cost flash coolers

Send for this new booklet—you'll see how the Swenson Flash Cooler can be custom engineered to your exact requirements. Various construction materials, flash nozzles and other adaptations are discussed. Sections of the booklet are devoted to single stage vs. multiple stage cooling and to flash coolers for heat recovery and heat interchange. Send for this valuable information today! Request Bulletin SW-204, "Swenson Flash Coolers." *Swenson Evaporator Company, 15669 Lathrop Avenue, Harvey, Illinois.*

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traits? As explained by Hewitt S. Welch, development engineer on the Clupak project, the process builds stretch into the paper by compressing it lengthwise, and to some extent, crosswise at one station in the paper machine dryer section.

At Charleston, the process station is located about midway through the dryer section of the 265-in.-wide Fourdrinier paper machine. At this point, the rapidly moving (1,500 ft./min.) web of paper is still sufficiently wet to be plastic.

Station consists of one 4-ft. dia. heated dryer roll and three auxiliary rolls (see sketch). The auxiliary rolls control travel of a 1-in. thick, 2-ton rubber blanket around the dryer roll.

▶ **Bottleneck Effect** — The auxiliary roll which brings the blanket into direct contact with the dryer roll is loaded to hold clearance between the rolls to less than the thickness of the rubber blanket. Since the rubber is noncompressible, it must deform lengthwise and sidewise to get through this reduced clearance between the rolls.

In essence, the rubber acts somewhat like liquid passing through a venturi. Surface speed of the blanket or belt actually rises to a peak at the point where it first touches the dryer roll. It maintains this speed as it passes on through the nip between the rolls until it finally breaks away from the squeeze roll a short distance beyond the nip.

The moving web of paper feeds in at the point where blanket first meets the dryer drum. Movement of the belt, as it deforms and returns to normal while passing through the nip, compresses the paper lengthwise and crosswise to build in a stretch factor.

Moisture conditions and roll temperature are controlled carefully to lubricate the interface between paper and dryer roll with a film of steam. This assures slippage of the paper along the roll surface within the short distance where blanket speed is changing.

Even though the web of paper is traveling at 1,500 fpm., it is compressed completely before it has moved an inch away from the nip. Actually, by the time the blanket has returned to original thickness, the action is finished. Subsequent drying sets the compressed sheet permanently.

▶ **How Clupak Performs**—Right now, West Virginia is making Clupak kraft in multiwall sack, asphalting, waxing and standard converting grades with basis weights from 30 to 70 lb. and up to 13% stretch.

For Clupak paper used in multiwall sacks, optimum stretch is about 10% in the machine direction and 5% in the cross-machine direction. Performance test data indicate that these sacks withstand two to three times more punishment than comparable sacks made of regular kraft paper.

Optimum stretch for grocery bags is approximately 7%. Extensive tests with loaded supermarket checkout bags show that they withstand 20 or more suspension drops as against one or two for conventional kraft grocery bags.

Unusual toughness demonstrated by such tests promises to reduce unit weight of sacks and bags, yet still improve performance. If a user pays a 10-15% premium price for the paper, he may still save money by using substantially less paper for a given job. And superior performance will increase benefits to him still further.

▶ **Aims for Wide Use** — While Clupak is focusing immediate efforts on the multiwall sack and grocery bag, numerous other applications for Clupak paper are being investigated by prospective users.

To keep pace with these demands, Westvaco already has planned installation of an extensible process unit for a second large paper machine at Charleston. And a similar unit will be placed on a small specialty machine producing white papers at Luke, Md.

Final push to complete improvements to the process is expected to level off by late spring or early summer. At that time, Clupak Pres. G. E. Amerman expects to freeze final machine design and start to work out licensing arrangements with interested parties both here and abroad.

Crystallization Wins Hf-Free Zr for Reds

Russian scientific techniques, now getting closer-than-ever scrutiny, evidently differ from U. S. technology in field of zirconium purification.

Reportedly, the Russians have used fractional crystallization of potassium-zirconium fluoride to win hafnium-free zirconium for use in nuclear reactors. This method is no longer considered practical in this country.

A. L. Hock, chief chemist of Magnesium Elektron, Ltd., Manchester, Eng., recently commented on Red technique before a symposium on the "newer metals" held in Manchester. Hock noted that if electrolytic reduction of potassium-zirconium fluoride to zirconium metal could be successfully developed on a large scale, then Western interest in the crystallization-purification route would be revived.

U. S. Industrial Chemicals Co. studied this lengthy crystallization route before setting up its zirconium plant at Ashtabula, Ohio. According to a U.S.I. spokesman, this purification method is not as economical as liquid-liquid extraction of zirconyl chloride now used.

News Briefs

Ethoxylated products: Process Chemicals Co., Los Angeles, will soon bring on stream a 4.5-million-lb./yr. unit for making ethylene oxide condensation products: Condensates of ethylene oxide with nonyl phenol, 2-ethyl hexanol, long-chain synthetic alcohols, various amines.

Triacetate film: Celanese Corp. is now producing triacetate film in new facilities at Belvidere, N. J.

Chlorine-caustic: Diamond Alkali will terminate operating lease on chlorine-castic soda plant at Pine Bluff, Ark.

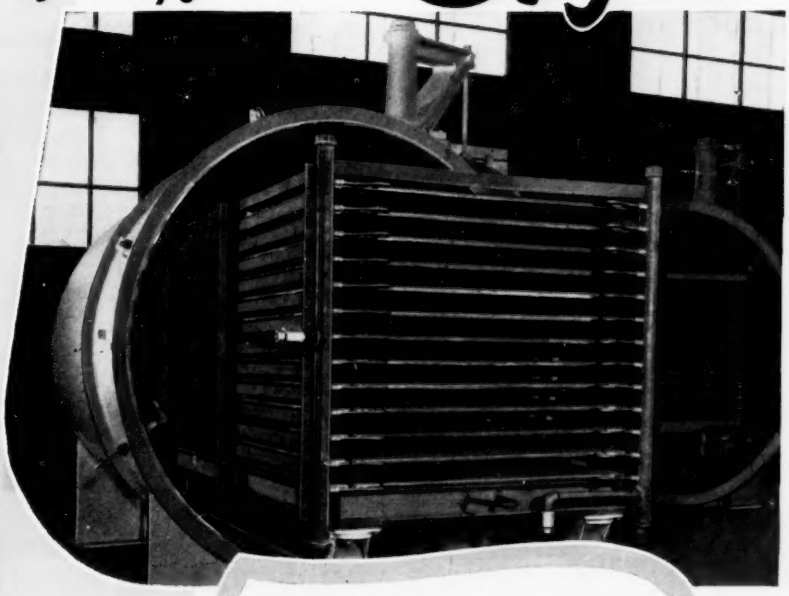
Paraxylene: Sinclair Chemicals last month started construction on a 50-million-lb./yr. paraxylene plant at Houston, Tex. On-stream date: early 1959.

new Devine Dryer

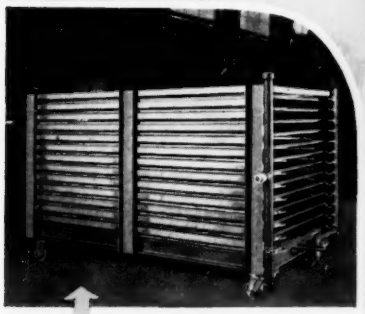
cuts handling by 50%

"Roll-Away" design increases drying capacity—up to 25% per Dryer,

by reducing down-time in multiple dryer operation

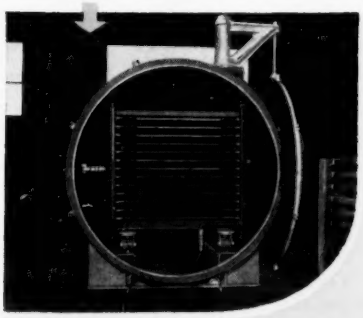


Four "Roll-Away" Dryers, same as pictured, are currently in operation at the Titanium plant of a nationally known metals producer.



While one rack of 12 loaded shelves enters dryer, an extra rack rolls away to be unloaded and reloaded for re-entry into dryer.

Rack inside dryer, ready to close door. Dryer has 12 shelves (standard 59" x 104") spaced 2 13/16" apart.



Proven "Roll-Away" Advantages Compared to Former Vacuum Chamber Drying:

formerly — Trays of product were handled four times, (1) loading to transport to dryer, (2) loading dryer, (3) unloading dryer, and (4) emptying trays.

now — Trays of product are handled twice, (1) loading rack of dryer shelves, (2) unloading rack of dryer shelves.

formerly — Dryer was inoperative while trays of dried product were removed and trays of moist product were loaded into dryer.

now — Dryer is inoperative *only* for time to roll out load of dried product and roll in load of moist product. This *semi-continuous* operation greatly increases drying capacity.

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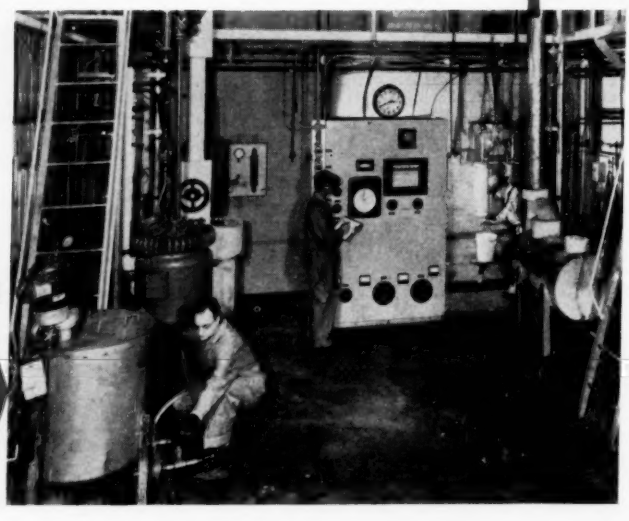
PROCESS EQUIPMENT

New process for ARYL MERCAPTANS, REFINING not synthesis



Process Feed
Mercaptan-rich stream tapped from cresylics refinery will feed process, now in pilot stage.

Good Market Bets to Match Volume Output
Pesticides
Rubber Chemicals
Dyes
Vinyl stabilizers
Pharmaceuticals
Oil additives

Aryl Mercaptan Output May Zoom

With volume output and lower prices in easy reach, Pitt-Consol is focusing on market development.

Tentative plans for quadrupling national output and more than halving prices of the aryl mercaptans are based on a new refining process. In contrast, current specialty quantities are made synthetically.

Prospective feed is an existing byproduct stream from Pitt-Consol Chemical's new cresylic acid refining plant at Newark, N. J., itself based on a process only slightly older than that for mercaptans (*Chem. Eng.*, July 1957, p. 228).

Timed to the progress of current market development work, the new process unit will be grafted to the Newark plant to produce from this stream about 400,000 lbs./yr. of thiophenol, 2,000,000 lbs./yr. of thiocresols and 750,000 lbs./yr. of thioxylenols.

At present about 500,000 lbs./yr. of thioxylenols, a maximum of 100,000 lbs./yr. of thiophenol and less than 100,000 lb./yr. of thiocresols are produced according to the best estimates. Much of this is for captive use, all of it is made synethetically. Evans Chemetics, Inc., New York, makes thiophenols, probably used mostly in pharmaceuticals. Du Pont makes thioxylenols, sells some in dilute form as a peptizer for rubber.

Prices of the individual compounds range up to $2.65/lb. which undoubtedly has had a throttling effect on the volume growth for these chemicals. Pitt-Consol hopes that by cutting prices to the 75¢ to 90¢/lb. range and offering large volumes, interest will be spurred.

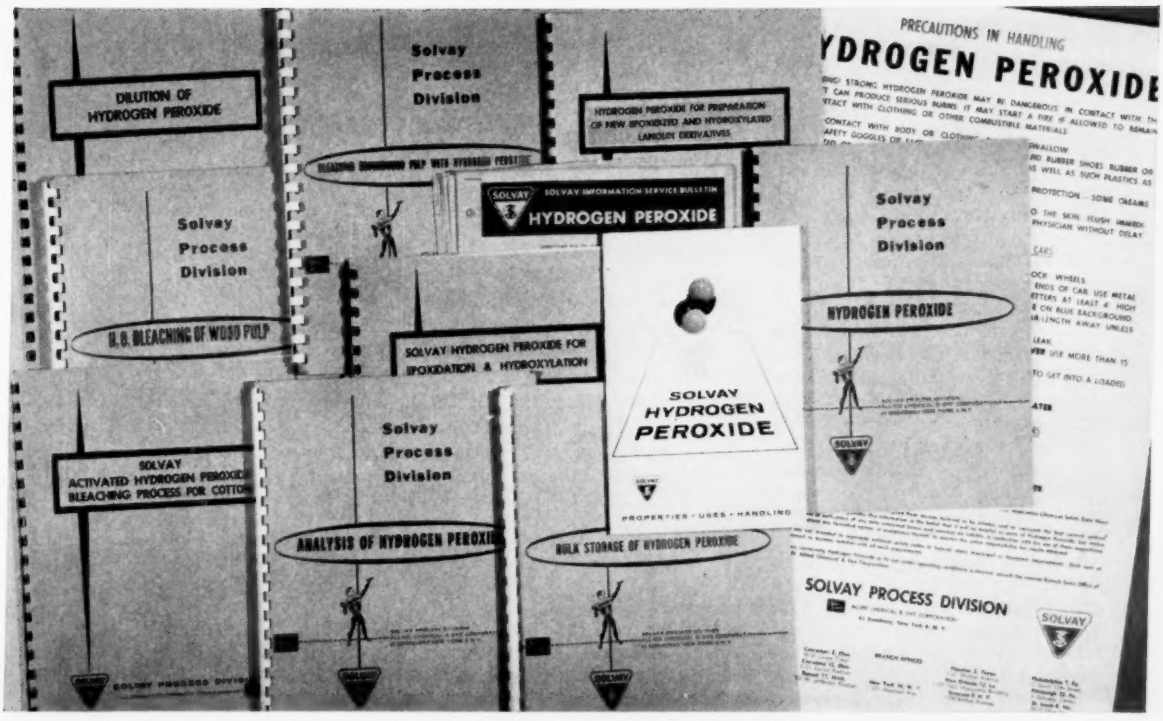
In this respect the company reports its search for volume markets has excited gratifying industry-wide interest, and has turned up good possibilities in such fields as pesticides, dyes and as stabilizers for resins.

Pesticides—The family of thiophenols may offer a new class of starting materials for the pesticide industry.

Para-thiocresol, for example, has shown itself to be as effective as DDT against housefiies and mosquito larvae. A thiol anaog of 2, 4D was found to have marked herbicidal activity.

Rubber Chemicals—The thiophenols, in the form of secondary amines have demonstrated delayed action acceleration. Pitt-Consol feels that additional experimentation might, with proper balancing of alkyl groups on the amine and various ring substitutions, yield a product superior to conventional thiazole type accelerators.

Dyes—Para-thiocresol or thiophenol condensed with halogen-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HYDROGEN PEROXIDE FOR PREPARATION OF NEW EPOXIDIZED AND HYDROXYLATED LANOLIN DERIVATIVES
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AVAILABLE TO YOU – TECHNICAL DATA ON SOLVAY HYDROGEN PEROXIDE

To help you in your current operations—here is authoritative information on the analysis, uses, handling and storage of SOLVAY Hydrogen Peroxide. These booklets, bulletins and the wall precaution chart have been compiled from accepted sources, from SOLVAY's own research and from 77 years of field experience with chemical consumers in virtually every industrial category. Check the contents of the individual items—then check those that may be helpful to you on the coupon and mail.

HP-1—Solvay Hydrogen Peroxide: Physical properties, chemical reactions, shipping containers, handling, storage. 21 pages.

HP-2—Wall Chart: Precautions for handling hydrogen peroxide.

HP-6—Hydrogen Peroxide Bleaching of Wood Pulp: Applications and methods. 28 pages.

HP-7—Hydrogen Peroxide Bleaching of Groundwood Pulp: Chemicals used, analytical methods, bleaching operations. 15 pages.

HP-9—Hydrogen Peroxide Bulk Storage: Bulk shipping and storage equipment, equipment suppliers. 13 pages.

HP-10—Analysis of Hydrogen Peroxide: Analytical methods, reagents, indicators, standard solutions. 31 pages.

HP-13—Solvay Hydrogen Peroxide for Epoxidation & Hydroxylation: Up-to-date review and bibliography, methods, olefins used, present and potential uses of products. 8 pages.

HP-14—Solvay Activated Hydrogen Peroxide Bleaching Process for Cotton: Process description, operation details, commercial applications, cost and quality comparison. 7 pages.

HP-15—Dilution of Hydrogen Peroxide: How to dilute accurately, equipment and materials needed. 9 pages.

HP-16—Hydrogen Peroxide: Up-to-date review of properties, stabilization, manufacturing methods, purification and concentration (prepared on request for new issue of Encyclopedia of Chemical Technology). 20 pages.

HP-17—Hydrogen Peroxide for Preparation of New Epoxidized and Hydroxylated Lanolin Derivatives: Study of preparation methods and determination of reaction products' characteristics. 8 pages.

NO. 1-56—Information Service Bulletin: Directions and equipment for emptying drums of hydrogen peroxide.

NO. 8-1057—Information Service Bulletin: Directions for unloading tank cars of hydrogen peroxide.

NO. 6-56—Information Service Bulletin: Hydrogen peroxide in oxidation of vat dyes.

NO. 2-57—Information Service Bulletin: Hydrogen peroxide in finishing electroplated surfaces.

NO. 6-657—Information Service Bulletin: Hydrogen peroxide in foam rubber manufacture.

NO. 4-57—Information Service Bulletin: Hydrogen peroxide in shellac bleaching.

NO. 7-957 and NO. 9-1157—Information Service Bulletins: Hydrogen peroxide in wood bleaching.

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ated phthalocyanines in a benzyl alcohol, potassium hydroxide solution at 200° gives a light-fast green dye. Other greens, yellowish greens, reds, blues and yellows can be produced by a variety of condensations.

Pitt-Consol is in the late stages of development of a process for ring alkylation directly by such aliphatics as isobutylene, which promises to eliminate the problems of low yield and the more expensive alkylation chemicals previously used. Alkylation is important because the alkylated thiols are not burdened with the classic drawback of mercaptans in general, their odor. In addition, their volatility is reduced and the oil solubility of derivatives is improved.

The company is conducting research toward separating thiocresol isomers, which represent the largest thiol product portion to come out of their process. The individual isomers will undoubtedly have interesting possibilities in a number of fine chemical applications which could not use the mixed isomers.

The feed for the mother cresylic acid process at Newark is spent caustic from washing catcracked gasoline, collected from 30 different petroleum refineries. The aryl mercaptans occur in the spent caustic stream, as do the cresylic acids, but in very low concentrations. In manufacturing the high-purity crysylic, Pitt-Consol gets a mercaptan-rich stream as a byproduct. This will constitute the feed to the proposed plant. Although the company has not divulged what processing steps will have to be taken, a partial view of the pilot plant is shown above.

Company will soon make available a booklet summing up its own research and developments reported in the literature on aryl mercaptan end uses.—**Pitt-Consol Chemical Co., 191 Doremus Ave., Newark 5, N. J.** **88A**

Protective Coatings

High in corrosion resistance, resilience, adhesion to surfaces.

A new series of primers and enamels are said to provide outstanding resistance to alkalies, acids, solvents, salt water and salt spray, humidity and vapors.

Called Koropons, the coatings are unusually resilient, boast good adhesion to metal surfaces.

They are available in three types: cold curing catalyzed for extreme conditions; heat curing or baking finishes for such uses as tank truck and tank car linings; air drying finishes for outdoor durability. — **United Wallpaper, Chicago.** **90A**

Zinc-Base Alloy

Use in metal dies consumes less metal, gives longer die life.

A new high-strength zinc base alloy for the aircraft and automotive industries in producing sheet metal stampings is said to cut die weights up to 20%, yet to provide longer die life.

Higher physical and mechanical properties of the new material, called Hi-Phy Kirksite, are typified by its 400% greater impact strength over older sister product, Kirksite A. Test results show the new product has a consistently greater degree of hardness, a substantially refined grain size, improved resistance to creep, more tensile strength and improved compressive strength.

Superior grain size has resulted in easier and higher quality machining and a minimum of grinding and finishing. Deeper draws can be made and stage dies often eliminated.—**National Lead Co., 111 Broadway, New York, N. Y.** **90B**

Antioxidants

Guard polyethylene-carbon black formulations 10 times better.

Certain substituted thioethers, when used in conjunction with carbon black, have been found to gain exceptional antioxidant activity over their use in clear polyethylene. Conventional protectants lose effectiveness in the presence of carbon black.

The best conventional antioxidants protect carbon black-polyethylene formulations for less than 200 hrs. under accelerated test conditions of 140 C. in an atmosphere of oxygen. Furthermore, the oxidation process becomes autocatalytic and accelerates when it reaches a certain point.

With several of the new protectants, oxidation proceeds at a slow, even rate and does not become autocatalytic even after 2,000 hrs. at 140 C. This is equivalent to much more than 20 yrs. of normal service life.

The substituted thioethers are formed by the condensation of conventional thermal antioxidants, such as aromatic amines or phenols, with sulfur dichloride. Alkyl, aryl and heterocyclic thiols and disulfides without amine or phenolic substituents

Newsworthy Chemicals

	Page number is also Reader Service Code Number
Aryl mercaptans verge on volume supply, new markets	88A
Coatings excel in corrosion resistance, adhesion	90A
New zinc-base alloy gives longer die life	90B
Thioethers guard polyethylene against thermal oxidation	90C
Silicone use broadened via reactive epoxy terminals	92A
Chlorinated *p*-xylenes now in pilot plant quantities	92B
Catalyst for polyester polymerizations cuts product crazing	92C
Synthetic oil vies for sperm oil uses	92D
Methylpyrazine, 2,5-dimethylpyrazine now commercial	92E
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You can *speed work—prevent leakage—save wear on equipment* by using an EVER-TITE in every operation that calls for couplings. Ever-Tite always gives you tight, quick connections because Ever-Tite has positive gasket compression that is dependable under *all* conditions. Get Ever-Tites—get a *quick, safe, tight* couple every time. Ever-Tites are available in:

STAINLESS STEEL
Aluminum • Malleable Iron • Brass
Other materials on request
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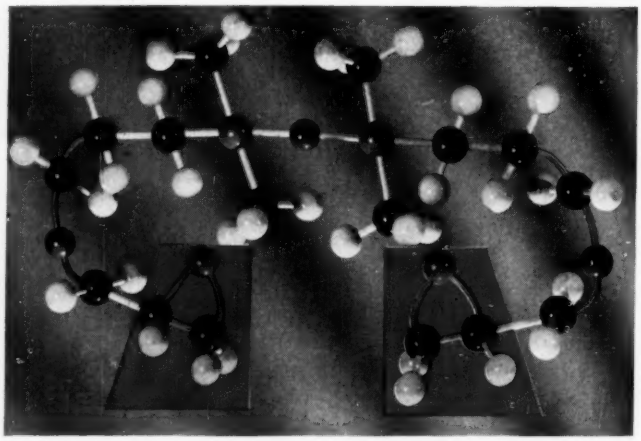
Chain for attaching Dust Caps on Dust Plugs to adapters or couplers

EVER-TITE COUPLING CO. INC., 254 WEST 54TH STREET, NEW YORK 19, N. Y.



Reactive Epoxy Terminals Broaden Silicon Use

Manufacturers of resins, dyes, waxes, oils, plasticizers, light stabilizers, heat stabilizers, pharmaceuticals and fungicides may find in a new organo functional silicone chemical a new approach to improved products.

Identified as Syl-Kem 90, the compound is 1,3-bis[3-(2,3-epoxy-propoxy)propyl] tetramethyldisiloxane, or an epoxy silicone combination with an epoxy group on each end of the molecule. The epoxy groups undergo the typical reactions of glycidyl ethers, making it possible to attach Syl-Kem 90 to a wide variety of chemicals. These hybrids may add useful silicone properties to the original chemicals.—Dow Corning Corp., Midland, Mich. 92A

are also effective antioxidants when used with polyethylene containing carbon black.

About 0.1% of the sulfur compound with 3% carbon black is highly effective in reducing both thermal and photo-oxidation. The carbon black, added to cut down photo-oxidation, accounts for the fact that a great deal of polyethylene in use today is black in color.—**Bell Telephone Laboratories, 463 West St., New York, N. Y. 90C**

Chlorinated *p*-Xylenes

Subject to chlorination, chloromethylation, nitration and more.

Six new chlorinated compounds utilizing *p*-xylene as the basic raw material are now available in semi-commercial quantities. All six can react further in such unit processes as chlorination, chloromethylation, nitration, sulfonation and oxidation.

Three of these new products are ring chlorinated, the remaining three are chain chlorinated. The chlorine in the chain reacts with hydroxyl, alkoxy, aryloxy, nitrile, isocyanate, amino, thio and other groups. Because of this reactivity, the chain-chlorinated materials can be used as chemical intermediates in the production of food-flavoring materials, perfumes, insecticides, fungicides, dibasic acids and aromatic diols or glycols.

The ring-chlorinated compounds are also expected to find use as chemical intermediates and as solvents, flame retardants and in the formulation of hydraulic fluids.—**Diamond Alkali Co., Painesville, Ohio. 92B**

Briefs

Catalyst for the polymerization of polyester resins at room or low temperatures, new ketone peroxide No. 6 is said to have advantages involving molding, casting or potting where crazing must be eliminated. —**Wallace & Tiernan Inc., Lucidol Div., Buffalo, N. Y. 92C**

Synthetic fatty-type oil called Smithol 25 has been introduced which offers some advantages over sperm oil and other natural fatty oils for industrial uses. Made from domestic raw materials, it has a lower cloud point and pour point and does not have the objectionable odor of some of the natural oils.—**Werner G. Smith Inc., 1730 Train Ave., Cleveland, Ohio. 92D**

Methylpyrazine and 2,5-dimethylpyrazine are now being produced for the first time in commercial quantities. Potential uses are in preparation of pharmaceuticals, high polymers, insecticides and dyes.—**Wyandotte Chemicals Corp., Wyandotte, Mich. 92E**

Flocculating agent called Polyox coagulant is a high-molecular-weight grade of company's new family of water-soluble ethylene oxide polymers (*Chem. Eng.*, Dec. 1957, p. 142). Family's newest offspring, the flocculant is said to be effective over a wide pH range in a number of systems including uranium ore slimes, silica suspensions, coal washery and other carbonaceous slurries, and clay suspensions.—**Union Carbide Chemicals Co., New York, N. Y. 92F**

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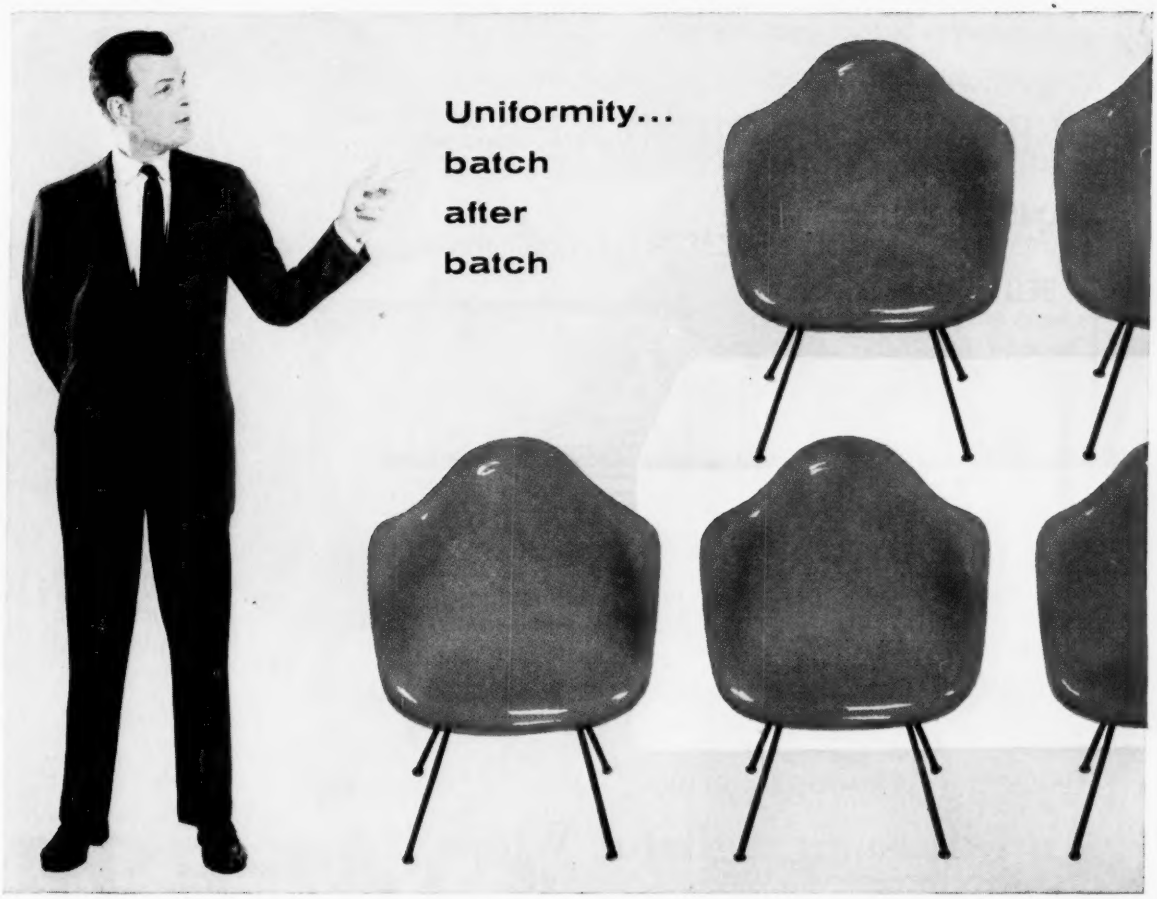

with

NEW POLYESTER RESIN GRADE DIETHYLENE GLYCOL

Now available is a new polyester resin grade of diethylene glycol. *This* CARBIDE *diglycol is produced specifically for the manufacture of polyesters and polyurethanes.*

Here are three outstanding advantages of this new polyester-resin grade chemical.

- Narrow boiling range which demonstrates product purity
- Controlled hydroxyl content assures uniform performance in processing
- Low ethylene glycol content to give polyesters with more uniform viscosity and excellent handling properties.

These stringent specifications help you obtain uniform batches—time after time.

Remember, whether you make a saturated or unsaturated polyester resin, there's a wide selection of CARBIDE glycols to choose from. These include —Ethylene glycol, Diethylene glycol, Triethylene glycol, Propylene glycol, Dipropylene glycol, 1,2,6-Hexanetriol and 1,5-Pentanediol.

For information on these glycols—or samples — write Union Carbide Chemicals Company, Room 328, 30 East 42nd Street, New York 17, New York. In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Montreal.

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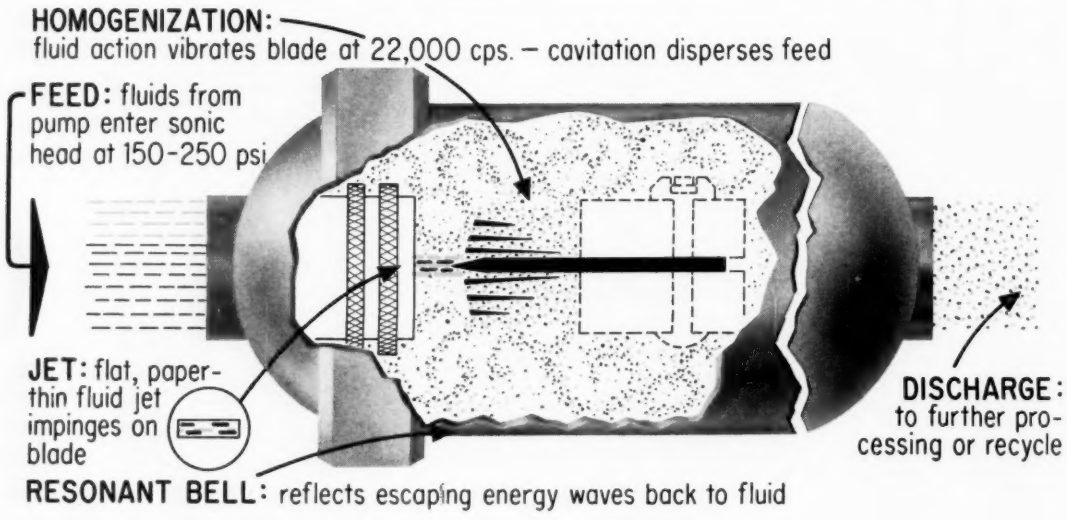
CHEMICALS

Union Carbide Chemicals Company
Division of Union Carbide Corporation
30 East 42nd Street, New York 17, N. Y.


HOMOGENIZATION:
fluid action vibrates blade at 22,000 cps. — cavitation disperses feed
FEED: fluids from pump enter sonic head at 150-250 psi
JET: flat, paper-thin fluid jet impinges on blade
DISCHARGE: to further processing or recycle
RESONANT BELL: reflects escaping energy waves back to fluid

APPLICATIONS SNOWBALL WHEN . . .

An Ultrasonic Agitator Whips It Up

Super homogenizer, at 1/5 normal capital outlay, completely emulsifies the difficult or the simple in less time with 1/10 usual power.

Introduced into this country from England only a few years ago, a line of ultrasonic homogenizers is rapidly gaining ground in the highly competitive equipment game. New fields of application—from peanut butter to high-octane gasoline—are uncovered almost daily.

Although primarily designed for emulsifying, these amazing machines find frequent use as dispersers, super mixers, blenders and viscosity-builders.

Virtually all energy input to the machine is developed and transmitted to the materials being handled. Energy transfer from input motor to fluid is simple and direct—the motor-driven pump forces fluids being emulsified through a nozzle; the fluids leave the nozzle and impinge on a thin blade of steel, causing it to vibrate at ultrasonic frequency; violent pressure changes, caused by cavitation at the blade, are put to work in the liquids.

▶ **Advantages Are Welcome**—In addition to a high ratio of liquid output to power input, simple design of sonic homogenizers permits a selling price only 1/5 that of other machines with similar output. And, they offer continuous emulsification without the need for premixing, even for liquids with widely different densities. Also, the absence of large shear forces at the blade enables manipulation of slurries without danger of thixotropic-property breakdown.

Additional advantages of extreme versatility, ease of maintenance and installation, compactness, and absence of product aeration round out the list.

▶ **Paper to Hamburger** — Sonic Engineering describes its homogenizers as capable of handling any fluid "that will flow by gravity." More recent applications, however, have extended this range to 'anything that can be pumped.' The machines have shown excellent form with paper pulp, rubber blends and even hamburger.

A Midwestern peanut butter manufacturer takes pains to advertise a superior product that is ultrasonically homogenized.

Normally one of the hardest emulsions, that of essential oils and stabilizing gums in water, is achieved with ease by sonics.

More common uses include the making of silicone emulsions, salad dressings, vitamins, textile printing emulsions and scores of others.

Applications are not limited to emulsions alone. As a super mixer, the sonic homogenizer excels, for example, as a means of dispersing 95% sulfuric acid in gasoline. Resultant large total surface areas lead to more complete reaction and a higher-octane product.

Vis-building is one of those unexpected, but often welcomed,

SULPHUR *helps to create* **HEADLINE** *products*

BORANES

The latest word in rocket and missile fuels!

This combination of Boron as the active oxidizable ingredient and hydrogen peroxide as the powerful oxidizing agent is proving to be one of the most powerful propellent fuels yet developed. The mixture is called BORANE.

Both Boranes and Hydrogen Peroxide owe their existence to Sulphuric Acid, the important reaction chemical in changing borax into boric acid from which the Boranes are derived. Sulphuric Acid also is the starting point in the production of hydrogen peroxide.

It is difficult to find any commodity stemming from chemicals, either organic or inorganic, that doesn't meet up with Sulphur or a derivative somewhere along the line. Quite often the Sulphur radical appears in the chemical structure of the commodity itself. Many, many times it plays an important role in the production of the headline product . . . just as in the case of the BORANES.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas

Sulphur Producing Units
- Newgulf, Texas
- Moss Bluff, Texas
- Spindletop, Texas
- Worland, Wyoming

results that occasionally occur when a material is pushed through the machine. For example, a finely ground, insoluble, inorganic powder, dispersed in water by standard methods of mixing, quickly settled out. When a sonic homogenizer was tried, a few hundred grams of the powder and a couple liters of water set up to give a product with permanently dispersed particles, and a consistency similar to that of tomato juice.

And speaking of tomato juice, sonics are, in fact, now used to raise final juice viscosities too.

All in all, ultrasonic homogenizers are finding increasing usage in just about every nook of the CPI and related industries —chemicals, cosmetics, foods, leather, pharmaceutical, photographic, rubber and textiles.

▶ **Construction and Operation**—Heart of all models is the ultrasonic head. This consists of a thin stainless steel blade, a jet-spray nozzle and a resonant bell.

The work-hardened blade is clamped rigidly at one end. The other end, which protrudes about ½ in. out from the clamp without support, is free to vibrate under influence of a moving fluid jet stream.

Three nozzles, each having a different size orifice, permit adjustment of jet-stream pressure.

The resonant bell, which also serves as an outer, air-excluding casing for the head's vital elements, reflects escaping energy waves back into the liquid stream.

Normally, a precision gear pump transmits energy from motor to liquid. One model, however, uses a continuous-cavity pump to enable the handling of dispersions and abrasives. An extra pump inlet gives flexibility to operations involving simultaneous introduction of more than one separate liquid phase.

In operation, a flat, paper-thin jet of liquid, oriented with width parallel to that of the blade, impinges at 150-200 ft./sec. on the knife-edge, causing it to vibrate at its natural frequency of 22,000 cps. Optimum operating pressure, as controlled by nozzle size, falls between 150 and 250 psi. With some liquids, stream pressures above 250 psi. begin to dampen vibration; blade vibration is curtailed below 150 psi. in other liquids.

Cavitation bubbles form on tiny impurities or added solids as they pass along the blade. Resultant tensile and compressive pressures, on the order of many thousands of atmospheres in amplitude, impart the necessary energy to the liquid.

Recirculation of a drag stream, or sometimes all of the flow, helps to attain highest degrees of emulsion or dispersion.

▶ **Models and Capacities**—Ultrasonic homogenizers are available in four basic models: Rapisonic, Dispersonic, Autosonic and Minisonic.

The Rapisonic, first of the line to be developed, is the standard production-size unit. Driven by a 2-hp. motor, it delivers about 400 gph. Multiple-head units, consisting of a larger gear pump and several sonic heads joined by a manifold, are available for higher throughputs. The largest unit quoted thus far contains 16 heads on one manifold; it's rated at 166 gpm.

The Dispersonic, a machine for dispersions and abrasive emulsions, uses the same Rapisonic head. However, instead of a gear pump, it develops stream pressure with a continuous-cavity pump. Maximum output is 350 gph.

Geared for continuous, simultaneous emulsification of three different streams (usually water plus some oil and an emulsificant), the Autosonic model combines a Rapisonic unit with integrated proportioning pumps, controls and meters.

Minisonic finds wide use for emulsifying gallon-size batches in small-scale operations, or as a pilot-plant tool.—**Sonic Engineering Corp., 146 Selleck St., Stamford, Conn.** 94A

Equipment Developments

Page number is also Reader Service Code number

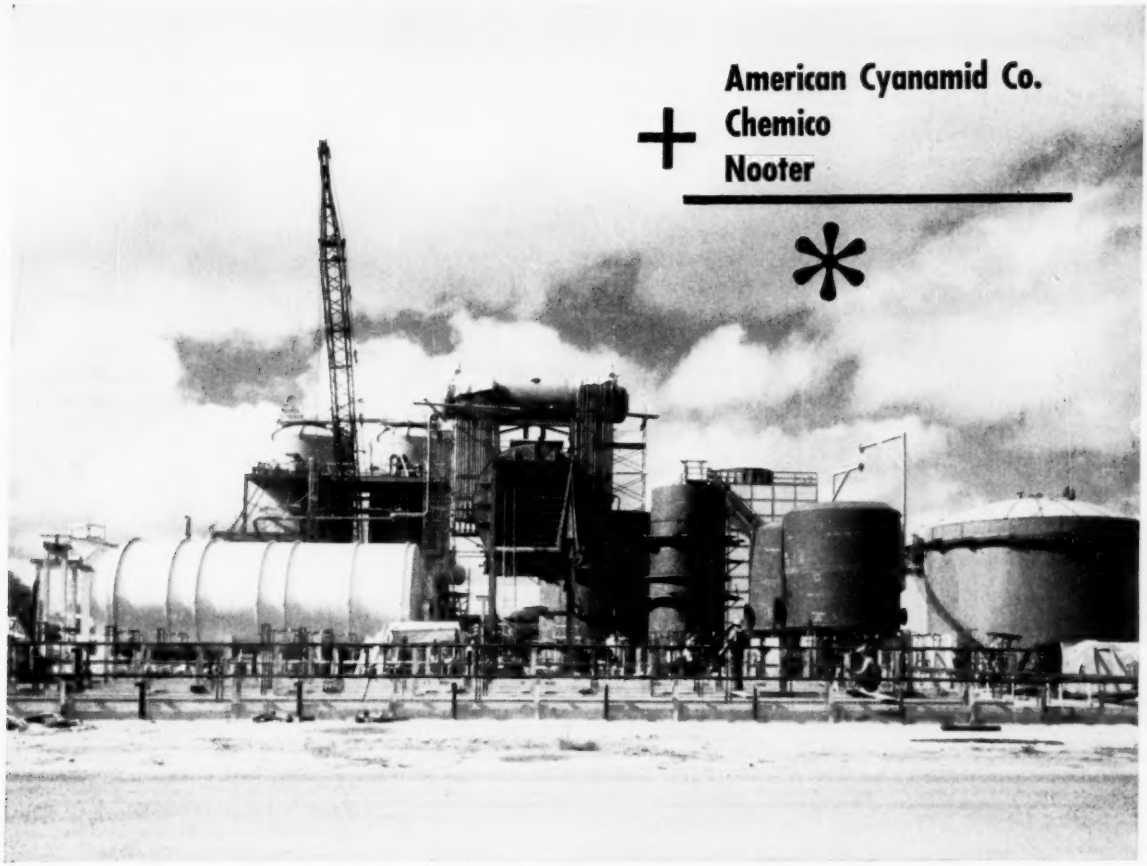
Ultrasonic homogenizer finds many new applications.....94A
Overload system protects rectifiers.....98A
Coextruded metals offer economic corrosion resistance....98B
Welder mass-produces metal gratings.....98C
Lift truck without masts features excellent visibility....98D
Cylinder filler weighs less, lasts longer.....98E
Gall-free valve functions without seat wear.....100A
Filter-leaf cleaner shakes cake off.....100B
Density gage uses gamma rays to measure density.....100C
New welding wire and rod will soon make debut.....100D
Electrolytic cell turns out high-purity hydrogen.....100E
Colored packings eliminate guesswork.....100F
Tank cleaner washes vessel interiors automatically.....100G

For more details, use Reader Service Card

Equipment Cost Indexes

	Sept. 1957	Dec. 1957
Industry		
Avg. of all	225.0	229.2
Process Industries		
Cement mfg	216.6	220.7
Chemical	226.6	230.4
Clay products	210.4	214.4
Glass mfg	214.0	217.6
Paint mfg	217.4	221.6
Paper mfg	218.3	222.0
Petroleum ind	222.0	226.3
Rubber ind	224.8	229.1
Process ind. avg.	223.7	227.0
Related Industries		
Elec. power equip.	229.8	232.9
Mining, milling	228.0	231.8
Refrigerating	254.0	258.9
Steam power	212.8	216.9

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143–44 for annual averages since 1913.



*they all add up to on-time performance for this triple superphosphate plant!

When American Cyanamid Company decided to expand its facilities for the manufacture of triple superphosphate, it looked to Brewster, Florida, for the plant site, and to the Chemical Construction Corporation for the designing and building of a new fertilizer plant.

It is significant that Chemico, in turn, called in the Nooter Corporation to custom fabricate and field erect all the tanks and processing vessels for the sulfuric acid facilities of this "fertilizer factory". Through past association, Chemico has learned to depend on Nooter skills for several important reasons:

(1) Years of specialized experience in the field of custom fabrication enabled Nooter to offer many time- and dollar-saving suggestions both before and during the plant installation.

(2) Nooter's extensive experience in field erection meant top assurance of on-time deliveries.

(3) The quality of Nooter workmanship is known and respected from coast to coast. This fact, plus Nooter's competitive price, made them the natural choice for the job.

This is the kind of service you can expect from every Nooter job, whatever its size or location. Why not call Nooter for your next custom fabrication, whether shop fabricated or field erected? You'll find that Nooter quality and dependable schedules are your best equipment investment.

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Overload System

Speed safeguards germanium rectifiers.

Direct shorts or a.c. transient overloads are blocked within 2½ cycles by the exclusive Ferro-Magnetic overload system.

Especially valuable for any germanium rectifier, overload relay operation is based on a magnetic amplifier principle. "Balancing cores" provide an additional safeguard for germanium diodes by distributing a.c. surges to other rectifier phases. — **Rapid Electric Co., New York, N. Y.** 98A

Coextruded Metals

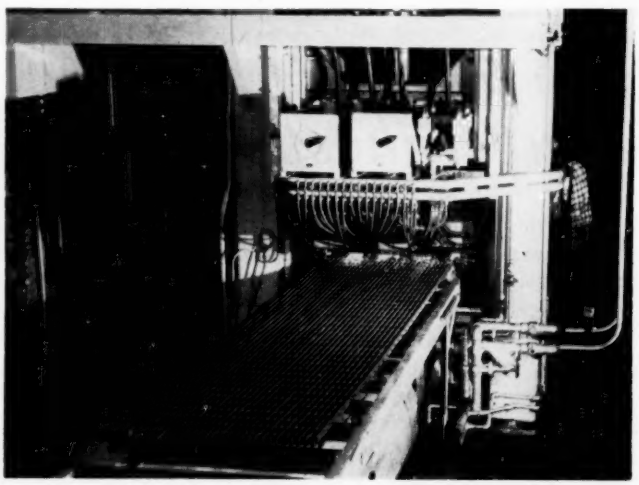
Many combinations produced by new technique.

By use of recently developed coextrusion techniques, tubing, rods and special shapes now can be made from many different combinations of base metals plus cladding.

Process presses two or more materials simultaneously through a die at elevated temperature to produce cladding on one or two sides of a base material.

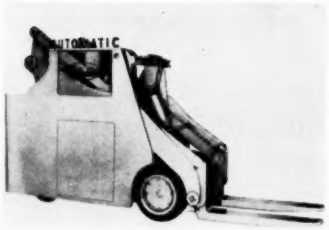
The dimensions of the original extrusion billet and the die through which the billet is extruded determine those of the composite.

One of the products now available is seamless copper tubing, clad inside and outside with zirconium. Other combinations can be made with copper, mild steel, aluminum, beryllium, uranium or thorium base material clad with zirconium, stainless steel, nickel, chromium, tantalum, titanium, platinum, aluminum, molybdenum and magnesium. — **Nuclear Metals, Inc., 224 Albany St., Cambridge 39, Mass.** 98B



Welds Gratings in a Big Way—440 Sq. Ft./Hr.

Claimed to be the world's newest and most modern automatic welding machine for metal grating, this goliath can spew out about 3500 sq. ft. per 8-hr. shift. Machine consists of a Verson 125-ton hydraulic press fitted out with special controls and an indexing unit to give positive cross-bar spacing. Four 300-kva. resistance-welding transformers service the machine. — Klemp Metal Grating Corp., 6601 S. Melvina Ave., Chicago, Ill. 98C



Lift Truck

New linkage eliminates masts on fork-lift trucks.

The Elbolift, a fork lift truck without masts, can lift loads ranging from 12,000 to 20,000 lb. to a height of 10 ft. The lifting linkage, somewhat similar to that of a bucket-type loader, has built-in retraction features to insure a straight up-and-down lift.

Elimination of the masts results in a great reduction in over-all weight, and a visibility that permits observance of the forks at all heights. Foot inching at each of its four forward or reverse speeds, combined with a new type of handle steering, provides excellent maneuverability. Hydraulically powered side shifter, adjustable forks, and ram are optional.— **Automatic Transportation Co., 149 West 87th St., Chicago 20, Ill.** 98D

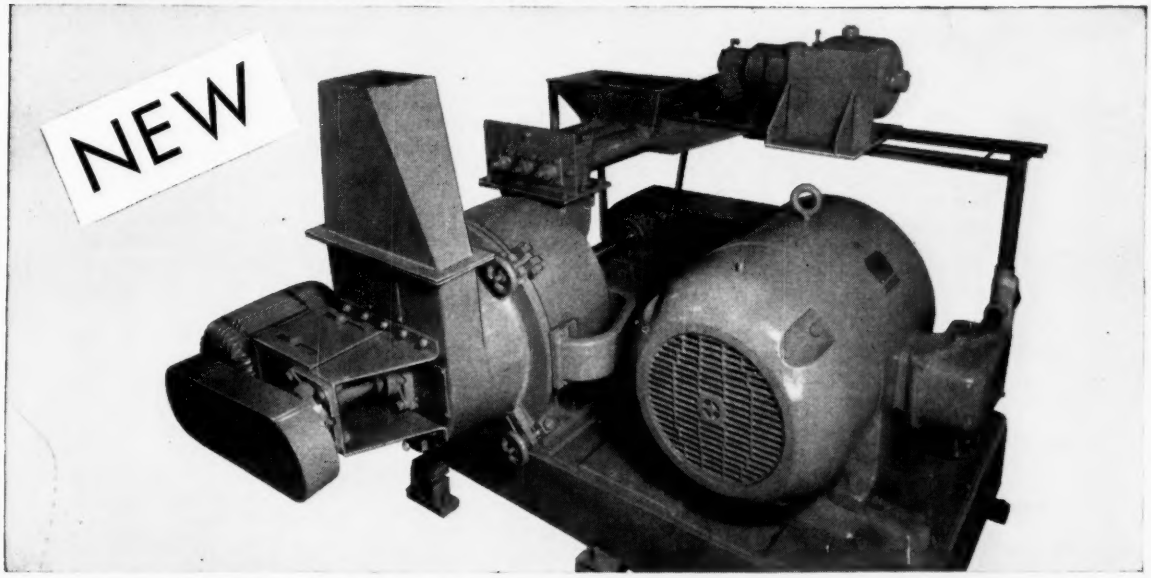
Cylinder Filler

Improved silicate filler cuts cylinder weight.

A new cylinder filler, recently introduced by the Linde Co., has been claimed to be the most important gas transportation development in 50 years.

Acetylene cylinders filled with the improved calcium silicate porous mass weigh up to 28.6% less than cylinders containing charcoal filler.

Besides the feature of 92% porosity (compared to their previous maximum of 82%), the new filler boasts a life greater than the steel cylinder shell itself. In addition, charging and discharge is faster than that of any other filler.—**Linde Co., Division of Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.** 98E



FOR PRECISION GRINDING AND CLASSIFYING IN ONE OPERATION

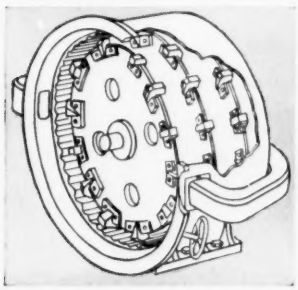
The PULVOCRON . . .
An Air Attrition Impact Pulverizer and Classifier with Controlled Radial Inward Air Classification.

Now in one compact unit you can have a pulverizer and a classifier plus an automatic feeder, with separate controls over each. This assures positive particle size control and high capacity over a wide range of products. The Pulvocron will produce particle sizes from a range of 99% less than 5 microns or as coarse as 50 mesh, depending on the material and desired results.

The grinding chamber contains three adjustable plates with twelve staggered beaters on each. It also features added versatility through interchangeable liners of corrugated, perforated or smooth finish, plus variable rotor stator clearances.

The Classifier unit is on a hinged section with quick-open locks for simplicity of operating adjustment or cleaning.

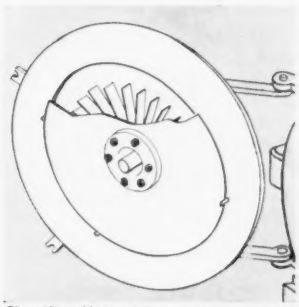
Material is both ground and classified through high centrifugal pressures set up by the beater and classifier plates. The Pulvocron is designed with oversize returns for automatic feed back of any oversize for further grinding.



Grinding chamber with adjustable plates, removable liners and oversize returns.

CONSULT STRONG-SCOTT

Strong-Scott offers you a modern up-to-date laboratory containing specialized testing equipment. This is backed by an expert engineering staff to furnish layout and design service at no additional cost to you.



Classifier Unit with separate motor. Swings open as a hinged section with quick open locks.

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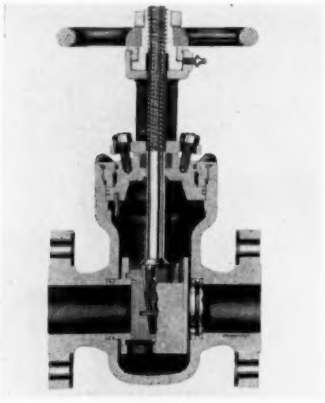

Gall-Free Valve

New valve design concept stops seat wear.

Designed for minimum maintenance, the new Keroseal double-block valve completely eliminates galling and wear of seating surfaces.

In addition, vapor-tight, Teflon-insert seals insure against product leakage. And, removal from process lines for occasional servicing is not necessary.

Both upstream and downstream disks are withdrawn from contact with the seat rings in the body before raising them. This eliminates drag during the opening operation.

On closing, after the point of final closure is reached, a wedge-shaped spreader once again forces the disks against the seat rings.

Carbon steel valves are available in 2- to 6-in. sizes. Larger valves of alloy steel will soon be in production.—**Kerotest Mfg. Co., 2525 Liberty Ave., Pittsburgh 22, Pa.** 100A

Filter-Leaf Cleaner

Vibrator peels cake from leaves within seconds.

You can slash filter leaf-cleaning time to less than 1 min. through use of a new vibrator. Attached to a yoke which transmits vibrations to the leaf-pack tie rods, vibrator works well on filters ranging from 100 to 1,000 sq ft.

Recent tests conducted by the manufacturer indicate just how fast this device strips cake from leaves. Cake consisting of nickel catalyst, diatomaceous earth and residual hydrogenated vegetable oil dropped away cleanly from the leaves with only 10-sec. vibration. A second test with cake cooled below the solidification point of the oil, released the cake completely after 30-sec. vibration. — **Hercules Filter Corp., 175 Ethyl Ave., Hawthorne, N. J.** 100B

Density Gage

Surveys variables without physical contact.

The new AccuRay Density System can measure and record or control fluid variables of density, specific gravity or percent solids. Results are independent of flow rate and pressure.

The gage, essentially a gamma-emitter and a monitor welded on opposite side of a process-line pipe insert, shows accuracies up to ± 0.001 sp.gr. with liquids, slurries and divided solids.

Temperature-correction and calibration circuits are built into the instrument. Sizes for 3- to 8-in. pipe are standard; other sizes are available on special order.—**Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio.** 100C

BRIEFS

New welding materials, Inco-Weld "A" Wire and a hard-surfacing rod, will be demonstrated at the 1958 Welding Show. The wire joins dissimilar alloy combinations; the rod imparts abrasion resistance to low-alloy steels.—**The International Nickel Co., Inc., 67 Wall St., New York 5, N.Y.** 100D

Electrolytic cell, the Electolyser, generates as little as 135 scfh. of high-purity hydrogen at an efficiency comparable to larger cells.—**Columbia Technical Corp., 61-02 31st Ave., Woodside 77, N. Y.** 100E

Color-coded mechanical packings for chemical processes provide positive service identification. Packings intended for weak acids, strong acids, and weak or strong bases are differentiated by several colors.—**A. W. Chesterton Co., Everett 49, Mass.** 100F

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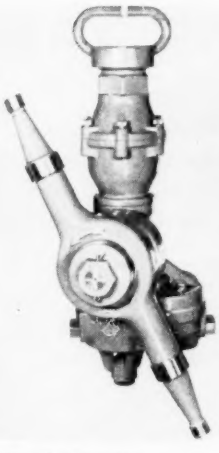


Tank Cleaner

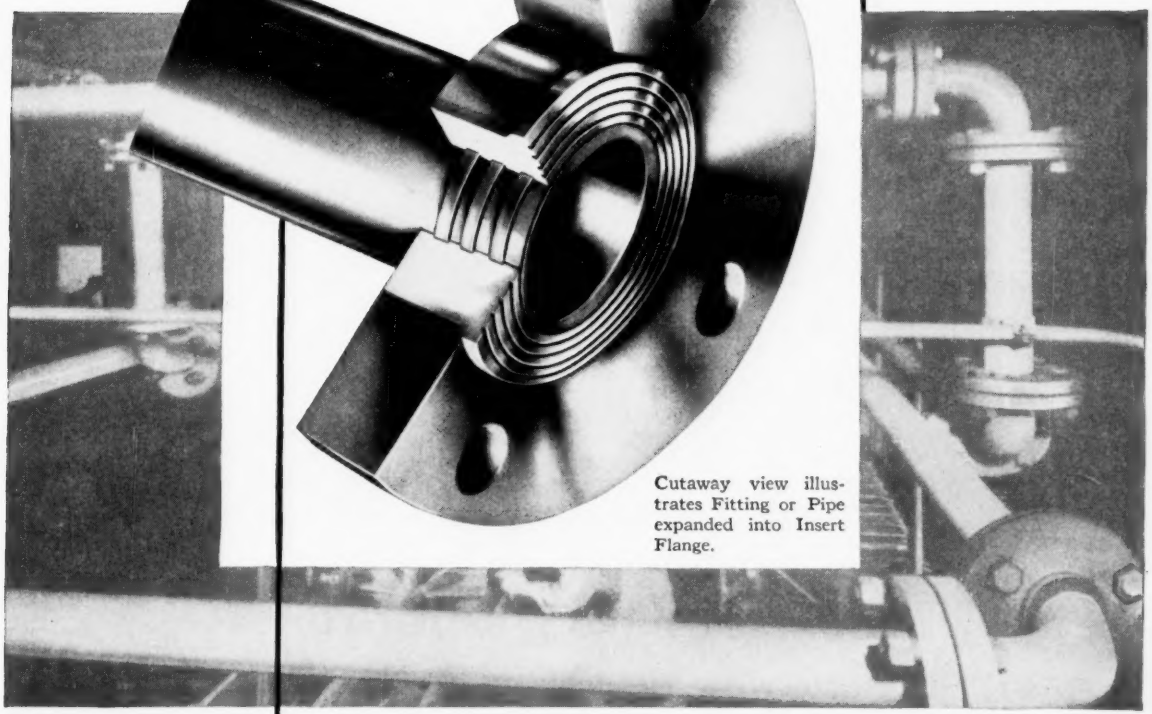
Cleans largest tanks automatically with jets.

Twin revolving jets on a jumbo tank cleaner deliver up to 9,400 gph. over an effective cleaning radius of 50 ft. Designed for either industrial or marine service, this unit provides a spherical scrubbing pattern over the entire inner surface of the largest tanks.

Scrubber is lubricated by oil, requires only 114 psi. water pressure. Water temperature can range from cold up to 176 F. Simple, rugged construction assures reliable service. Spare-parts kit permits easy repair.—**Sellers Injector Corp., 1600 T Hamilton St., Philadelphia 30, Pa.** 100G

NOW...FLANGE WITHOUT WELDING

for Faster, Lower Cost Assembly of Leakproof Process Lines



Cutaway view illustrates Fitting or Pipe expanded into Insert Flange.

Speedline

SPEEDLINE IS A REG.T.M. OF HORACE T. POTTS COMPANY

Speedline Insert Flanges provide leakproof joints—*without welding*—and maintain the high quality control standards required for the most complex processes.

"With Speedline Insert Flanges, we have stainless steel bonded to stainless steel, rolled in under pressure for a permanently leakproof installation of transfer and manifold lines", reports Plant Engineer at a Chicago plant.

The "tangential" feature, exclusive with all Speedline formed fittings, allows for direct attachment of Insert Flanges by simple expanding operation.

Learn how the complete line of Speedline corrosion resistant fittings assure piping economy and efficiency not possible with conventional fittings. Write for a copy of "Speedline Catalog" today.

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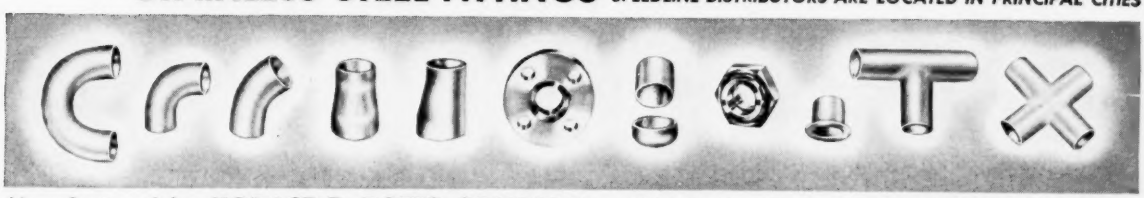

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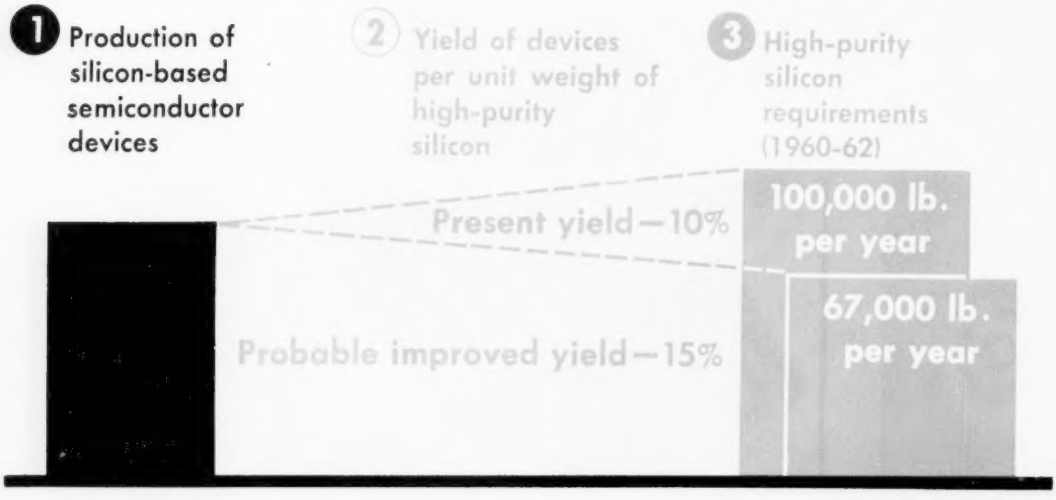
Semiconductor SILICON:
More Efficient Use Will Cancel a Chunk of Its Growth


1 Production of silicon-based semiconductor devices
2 Yield of devices per unit weight of high-purity silicon
3 High-purity silicon requirements (1960-62)
Present yield—10%
100,000 lb. per year
Probable improved yield—15%
67,000 lb. per year

Silicon Market: Shrinking as It Grows

That a pound of high-purity silicon may go further tomorrow is only one of the chemical producer's problems. The competition promises to be pushy.

If it's possible for a material's potential to appear fanciful, rich, transient, solid, fickle, expanding and contracting—all at the same time—then high-purity silicon looks the part.

Semiconductor-silicon's future is very rosy, of course. Unquestionably so. But chemical producers on their way to the Promised Land had better watch out for booby traps.

Take the question of how efficiently fabricators of electronic devices—transistors, diodes and rectifiers—can utilize a pound of this premium product. The hard, cold fact of the matter is this: The technology of semiconductor fabrication is as critical to high-purity silicon's future as anything the producers can do in the way of process, product or market development.

Right now not more than 10% of high-purity silicon raw material eventually winds up in a useful semiconductor device.* The rest is wasted en route.†

▶ **A Little Means a Lot** — Now suppose electronic fabricators sharpen their technology just enough to increase silicon's "electronic yield" to 15%. Any silicon market potential based on a 10% utilization efficiency is quickly shaved by one-third.

Market researchers hope they have allowed for this factor. But if they underestimate future electronic yields more than a little some of the growth for silicon they foresee will be neatly canceled.

▶ **Competition, Competition** — The utilization efficiency puzzle is only one problem, though, in the high-purity silicon field. Hanging over the whole scene is the certainty that chemical firms now in, or contemplating entry into, the high-purity silicon sweepstakes face the fiercest of competition.

• Competition from each other. Already there are four chemical entries—Du Pont, Eagle-Pitcher, Grace and Merck.

• Competition from captive producers. Texas Instruments, Sylvania and Westinghouse—all semiconductor fabricators—have their own production facilities

* Utilization efficiencies vary widely among fabricators, among the same devices for different purposes, among different devices (e. g. rectifiers vs. transistors). Lows of 1% are not unheard of. To quote an average figure is very tough. The only certainty: There's sure room for improvement.

† Any silicon rejected along the way is contaminated to the point where it is no better than sand as a raw material for high-purity grades.

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(FORMALDEHYDE IN SPECIFIED ALCOHOLS)

all about it in Celanese Product Bulletin S-23-5

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Celanese
CHEMICALS

Transistor Sales:

Germanium Devices Set a Torrid Pace

(Million Units)

	1954	1955	1956	1957	1958	1959
Silicon-Based Transistors						
Home entertainment	....	....	....	....	..	..
Commercial & industrial	....	....	....	0.2	1	2
Military	....	0.1	0.9	2.9	8	18
		0.1	0.9	3.1	9	20
Germanium-Based Transistors						
Home entertainment	1.1	2.3	4.5	8.6	21	50
Commercial & industrial	0.2	1.2	7.4	10.5	17	30
Military	*	*	*	4.8	12	25
	1.3	3.5	11.9	23.9	51	105
Total Transistors	1.3	3.6	12.8	27	60	125

Sources: 1954–56, Electrical Industry Assoc.; 1957–59, Stanford Research Institute. * Included with commercial transistors.

Diode and Rectifier Sales:

Watch Silicon Move Up Fast

(Million Dollars)

	1952	1953	1954	1955	1956	1957*
Silicon-Based Devices	3.3	2.5	2.9	7.1	20	35
Germanium-Based Devices	13.7	17.9	14.5	19.8	30	35
Total Diodes, Rectifiers	17.0	20.4	17.4	26.9	50	70

Source: Business and Defense Services Admin. * *Chem. Eng.* estimate.

Silicon vs. Germanium Semiconductors:

Technical Pluses for Both Sides

Silicon

Operates at higher temperatures (200 C. vs. 100 C.).

Lower density (about half germanium's) enables it to go twice as far volume-wise (criteria for semiconductor wafers).

Handles higher current densities, (35–40 times as much) a big advantage in power devices.

Higher reverse voltage tolerance permits more power-consuming units in series.

Germanium

Higher fabrication yields. Ninety percent winds up in useful electronic device. Only 10% of silicon does.

Greater electron mobility permits higher frequencies and faster-acting components.

Lower melting point minimizes contamination during processing.

Greater efficiency (99% vs. 98%) in power rectification is significant to areas with high-cost power.

for high-purity silicon. About 35% of all silicon capacity is captive.

• Competition for oversupplied markets. Capacity will soon be about double (see p. 106) the most optimistic predictions for demand—100,000 lb./yr. in 1961.

• Competition for silicon from other semiconductor materials like germanium (already strongly entrenched and growing) and lesser-known substances (but threats, nevertheless) like barium titanate, gallium arsenide, indium phosphide and silicon carbide.

• Competition from semiconductor substitutes like the solion and spacistor, which do not depend on high-purity semiconductors.

▶ **Silver Linings** — Why, then, have chemical firms, and others, been so eager of late to get into the silicon business? For one or more of these reasons: They are looking to make a fast, good profit and get out; they are counting on a special something to give them a quick and decided edge (product quality, process knowhow); they are seeking a foothold in a vital new technological field, and may figure on getting into semiconductors, or into ultra-high purity materials, in general. Or they may simply feel silicon's semiconductor potential is great enough to keep a lot of people happy. (They could be right.)

▶ **History Tells Us**—Let's look at some historic parallels that seem to bear out our words of caution.

Du Pont recently announced it will cease production of phosphors for cathode ray (including TV) tubes. One explanation: ". . . better tube-making methods which require less phosphor." Another way of saying phosphor utilization efficiency is up.

Also in the Du Pont announcement, another market-shrinker: ". . . entry of big tube producers into phosphor production . . ." Another word for captive competition.*

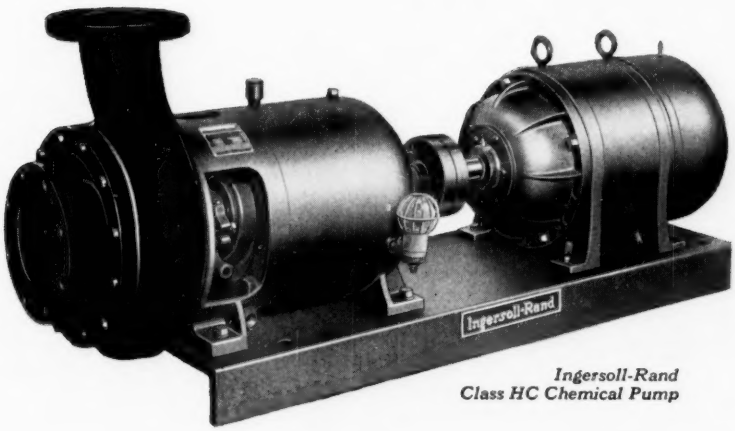
Remember the early days of the vacuum tube? Hundreds of producers. Today about ten take

* By contrast, however, electronic fabricators have turned over most of the responsibility for germanium production and purification to merchant producers.

Here's Why I-R Chemical Pumps Give You

EXTRA PROTECTION

. . . AGAINST CORROSION

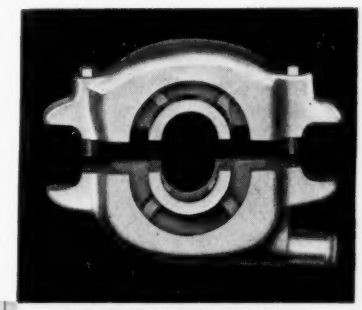


Ingersoll-Rand Class HC Chemical Pump

IRCAMET, developed by Ingersoll-Rand especially for chemical pump service, is a high nickel-chromium molybdenum alloy steel with exceptional resistance to the corrosive action of a wide variety of acid and alkaline solutions. All pump casing and impeller parts in contact with the liquid handled are made of IRCAMET. The shaft is made of a similar wrought alloy. For lasting external protection, the entire unit is sprayed with a special paint which is highly resistant to chemical action.

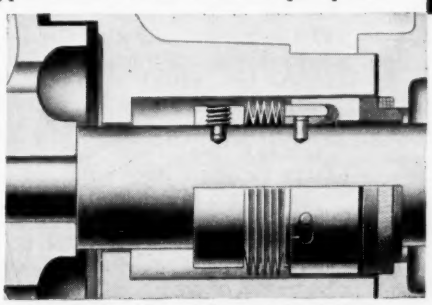
. . . AGAINST LEAKAGE

The LEAKOLLECTOR STUFFING BOX GLAND, furnished on all I-R chemical pumps, collects any stuffing-box leakage and provides for its safe collection or disposal. It fits the stuffing box closely, both inside and out, thus preventing cocking of the gland and escape of fluid. Split design for use with packed boxes permits easy removal from the shaft for repacking.



LEAKOLLECTOR stuffing box gland

The MECHANICAL SHAFT SEAL, which entirely eliminates stuffing-box packing, can be supplied on all I-R chemical pumps if desired. It greatly reduces leakage losses and, once installed, requires no further attention. While a single seal will handle most liquids, a double seal is available for handling abrasive, very hot, or very corrosive solutions.



Cross section of Cameron Shaft Seal

Ingersoll-Rand Chemical Pumps are available in sizes to handle up to 4,000 gpm at temperatures to 800F. For complete information, ask for Bulletin No. 7095-A. If you have a pumping problem, your nearest I-R representative will be glad to assist you in any way possible.

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High-Purity Silicon:

Chemical firms vie with captive producers . . . . . for electronic firms' favor

Silicon Producer	Designed Capacity (Pounds)[1]
Du Pont	70,000[2]
International Metalloids (Grace-Pechiney)	20,000
Merck	20,000
Eagle-Pitcher	70,000
Texas Instruments[3]	
Sylvania[3]	
Westinghouse[3]	20,000
Total Capacity	**200,000**

[1] *Chem. Eng.* estimates for all capacities save those of Du Pont and International Metalloids. [2] Includes 20,000 lb./yr. of solar-grade (lower-purity) silicon. [3] Includes capacity for captive production.

Silicon Consumer	Percent of Consumption
General Electric	20
Texas Instruments*	20
Sylvania*	10
Philco	10
Hughes	10
Transitron	10
Raytheon	10
Others	10

* These firms produce, as well as consume, high-purity silicon.

care of the nation's needs. Manufacturers of semiconductor devices could dwindle the same way.

There used to be 200-300 germanium producers. Now Sylvania and Eagle-Pitcher carry the ball practically by themselves. Why shouldn't silicon production centralize, too?

▶ **More Efficiency a Must** — At present something like 2¢ worth of silicon appears in a semiconductor device which costs $10. Even though 20-30¢ worth of high-purity silicon must be processed to achieve this, there's not much incentive now to increase silicon utilization. But if silicon transistors, say, are ever to sell in the $1/unit range, this raw material waste must be reduced somehow.

In the meantime, the electronic fabricator, painfully aware of a high reject rate, a high degree of hand assembly, is looking for ways to spruce up his production line. Raw material utilization will obviously benefit.

▶ **Things Will Work Out**—Prolonged oversupply is not likely simply because silicon for semiconductor use looks like too good a growth market (see p. 104). Transistors are soaring, will most likely snatch a good share of the vacuum tube's present half-billion-units/yr. market. Diodes and semiconductor rectifiers are just getting started, promise the greatest chance of a silicon breakthrough. Prices of silicon and silicon devices will come down as technology improves.

Overcapacity, in itself, isn't too serious anyway. Incremental changes in production levels for high-purity silicon can be accomplished at little cost. Plant investment is relatively low. What really costs the silicon maker most are his efforts in sales, technical service, market development and research (especially the development efforts prior to plant investment).

Chemical people—fewer, perhaps, than we see in the field today—will probably be the sole surviving silicon producers. Their big strength is in production of high-purity raw materials for somebody else; the electronic firm is preoccupied with device-making and will eventually prefer to buy, rather than make, semiconductor silicon. Besides, competition may soon dictate a minimum production rate too large for the needs of the individual electronic manufacturer.

Du Pont's withdrawal from phosphor production may be an unfair parallel after all. Phosphors can be doped (treated with measured impurities to make them functional) during initial purification. Germanium and silicon must be rendered pure first. Thus the phosphor-device fabricator prefers to combine doping with purification.

▶ **Silicon vs. Germanium** — As for the struggle between silicon and germanium for semiconductor applications, there's plenty of room for both (see p. 104). Here are their prospects in certain fields:

Entertainment — Low cost is important, high temperature tolerance is not. Score this use for germanium.

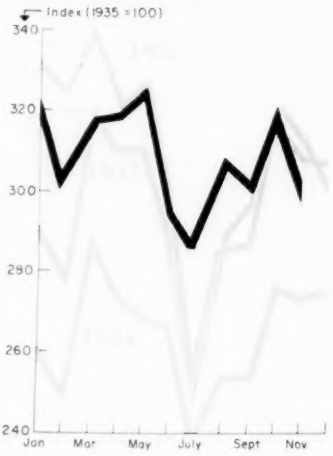
Communications—Capacity for high frequencies is vital. Score this use for germanium.

Computers—A tossup.

Industrial—Heavy load-carrying devices need silicon (exceptional performance more than balances extra cost).

Military — Germanium, its semiconductor technology further advanced, is ahead right now. But high-temperature uses will call for more silicon in the long run.

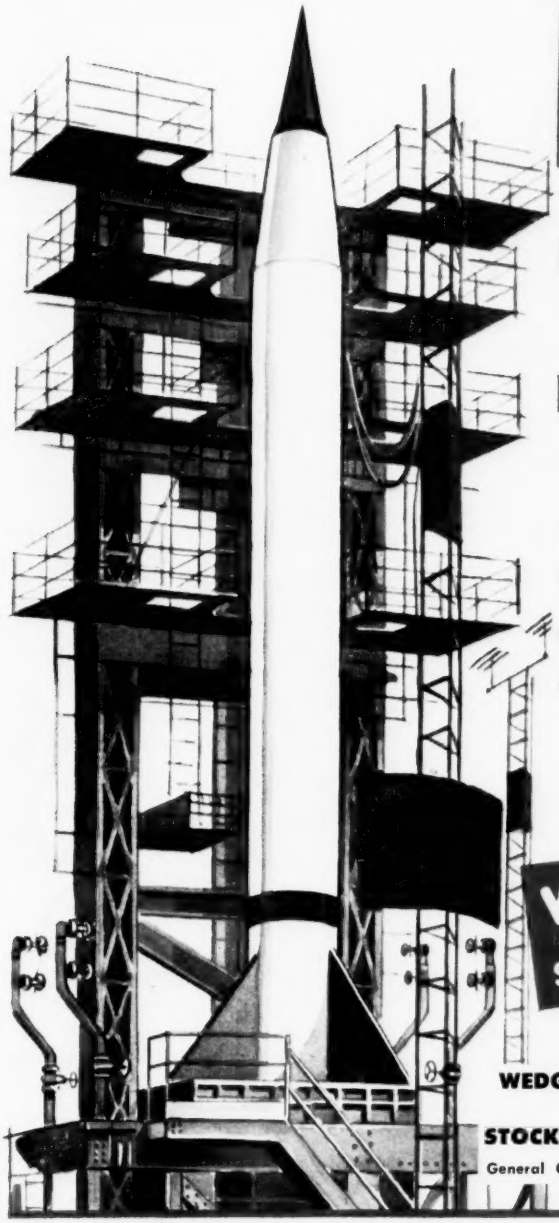
Chemical Consumption



Consumption by Industries

	Oct. (Final)	Nov. (Est.)
Coal products	11.2	10.2
Explosives	11.7	10.0
Fertilizer	72.2	68.7
Glass	28.7	25.3
Iron & Steel	16.9	15.4
Leather	4.0	4.1
Paint & varnish	32.2	27.3
Petroleum refining	31.1	30.1
Plastics	27.7	25.3
Pulp & paper	39.4	37.2
Rayon	28.8	27.2
Rubber	7.6	6.6
Textiles	10.6	9.4

THE VALVE WITH A FUTURE



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▶ **In the MISSILE INDUSTRY**

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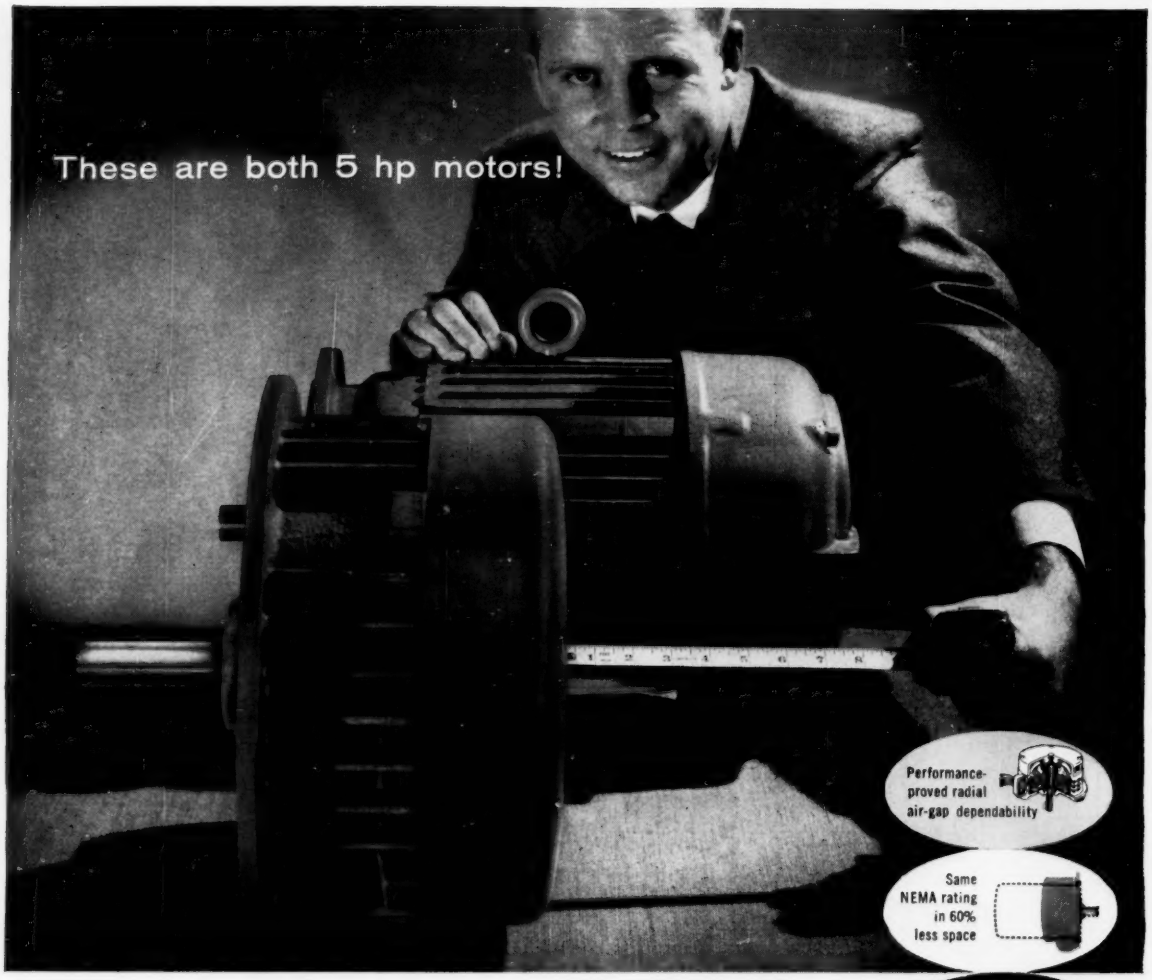

60% shorter– but with radial air-gap design!

New Louis Allis Pancake Motor preserves all the advantages of conventional motor construction

The new Louis Allis Pancake Motor is your solution to trouble-free power in any space-cramped motor application.

The Pancake is a remarkably short flange-mounted motor — up to 60% shorter and 33% lighter than standard motors of the same rating! And it is built in *conventional* radial air-gap design!

It's done by an ingenious forming process which literally compresses the end coils of a conventional radial air-gap motor into an exceptionally short length. The result is a compact, light motor ideally suited for horizontal or vertical mounting on machine tools, roof ventilating fans, or *any* close-quarter installation where space is a critical design factor.

What's more, this is achieved without sacrificing a single desirable characteristic: the stator still contains the same iron and copper as standard Louis Allis motors . . . standard NEMA service factor is maintained . . . high insulative values are retained by using proved Louis Allis varnishes and new insulating techniques . . . over-sized pre-lubricated bearings are used to guarantee long bearing life . . . and the entire motor is enclosed in an industrial-type cast-iron housing designed to shrug off abuse!

The housing and flange are cast in one piece: this permits extra-accurate internal machining which extends bearing life and reduces noise levels to a new low.

Investigate the Pancake Motor through your local Louis Allis District Office. Sized from 1 to 15 hp, at 1800, 1200, and 900 rpm, in open drip-proof and enclosed non-ventilated or fan-cooled enclosures. Write for Bulletins 2100 and 2150 to the Louis Allis Co., 447 E. Stewart St., Milwaukee 1, Wis.

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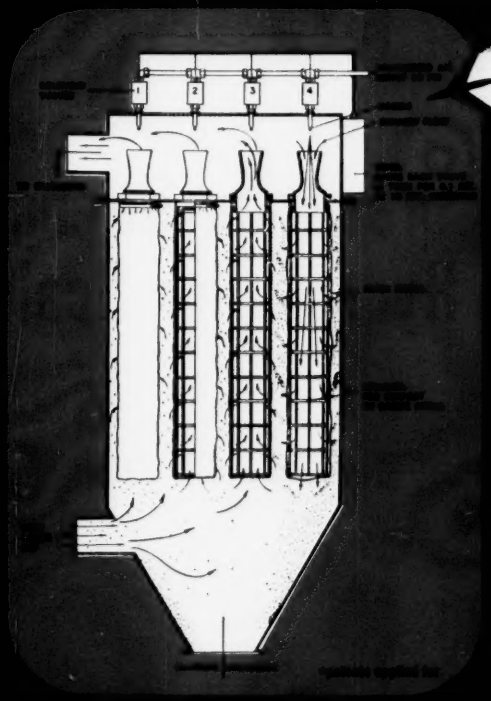

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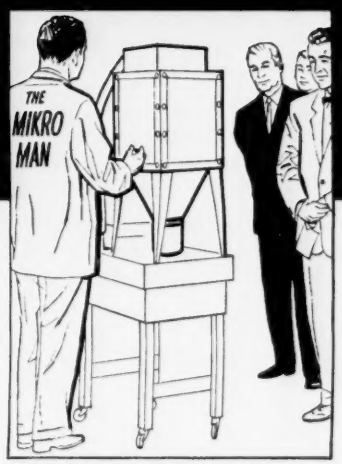
NO MAINTENANCE DOWN TIME!



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For additional product information and location of the MIKRO-MAN nearest you, see Chemical Engineering Catalog for 1958, pgs. 1467 to 1474.

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A COMPLETE LINE OF UNITS FOR ALL COLLECTION JOBS, FEATURING:

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Using Salt Efficiently

by INTERNATIONAL SALT COMPANY, INC.

How to Measure Brine Strength on Different Hydrometer Scales

The most common method of measuring brine strength in industry is to use some type of hydrometer. Every hydrometer sinks into a liquid until it has displaced a weight of the liquid equal to its own weight. The scale divisions on a hydrometer are not usually of equal length, since the volume of displaced liquid increases as more of the stem is immersed.

Using a hydrometer is a relatively simple process—but reading the hydrometer scale is complicated by this fact: the scale may vary from plant to plant because hydrometers may be used to measure strength of other liquids, as well as salt brine. To help clear up any possible confusion, here are an explanation and a comparison of the five most common hydrometer scales used for measuring brine strength.

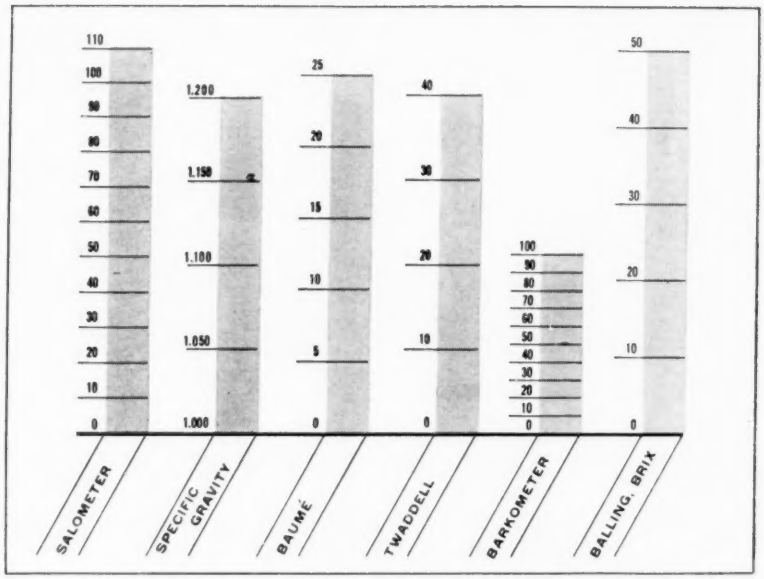
SALOMETER SCALE. This is by far the most common of all the hydrometer scales used for testing brines. The scale indicates directly the per cent saturation of the brine, reading 0° S. in pure water, and 100° S. in fully saturated brine. The salometer uses the values of Gerlach, meaning that 100%-saturated brine contains 26.395% salt by weight. Each salometer degree, then, represents 0.2639% salt.

The salometer reading expresses the per cent of saturation. Thus, a brine of 40° S. strength is 40% saturated, and contains 40% of 26.395%, or 10.558% salt by weight.

SPECIFIC GRAVITY SCALE. This reads the specific gravity of the brine *directly*. These hydrometers may be obtained with the entire length of scale covering a limited range of specific gravities, thus permitting great accuracy.

BAUMÉ SCALE. This scale was originally intended to have each degree equal a per cent of salt in the brine. But this is now only a rough approximation. The Baumé scale reads 0° Bé. in pure water, 24.6° Bé. in fully saturated brine. Also, a factor of "modulus" is needed to translate degrees Bé. to specific gravity, since the scale divisions are of equal length. This modulus has been standardized at 145, so that degrees Bé.=145–145/sp.gr.

TWADDELL SCALE. Named after its inventor, the Twaddell scale reads 0° Tw. in pure water, 40.8° Tw. in fully saturated brine. Each increase of 0.005 in specific gravity causes 1° increase on the Twaddell scale. Thus, the number on the right of the decimal point of the specific gravity, divided by 5, is the degrees Tw. For example: 1.140 sp.gr. is 140/5, or 28° Tw.



COMPARISON OF COMMON HYDROMETER SCALES

(Chart gives quick, visual relationships of readings on the salometer scale to readings on other scales.)

BARKOMETER SCALE. Used extensively for testing tanning liquors, the Barkometer scale reads 0° Bk. in distilled water, and 204° Bk. in fully saturated brine. Each increase of 0.001 in specific gravity causes 1° increase on the Barkometer scale. Thus, the number on the right of the decimal point of the specific gravity is the degree Bk. For example, 1.025 sp.gr. is 25° Bk.

The hydrometer scales described above are usually calibrated for brines at 60°F. temperature. When testing brines at other temperatures, it's necessary to make certain corrections...or to use a specially designed hydrometer. You can get a table showing proper temperature corrections, plus other data on measuring brine strength, from International Salt Company.

Using salt in its many industrial applications calls for technical knowledge and experience. International Salt Company has both—plus a continuing program of research and development in salt. These things can be put to work for you . . . in your plant . . . to help you get the most out of the salt or brine you use.

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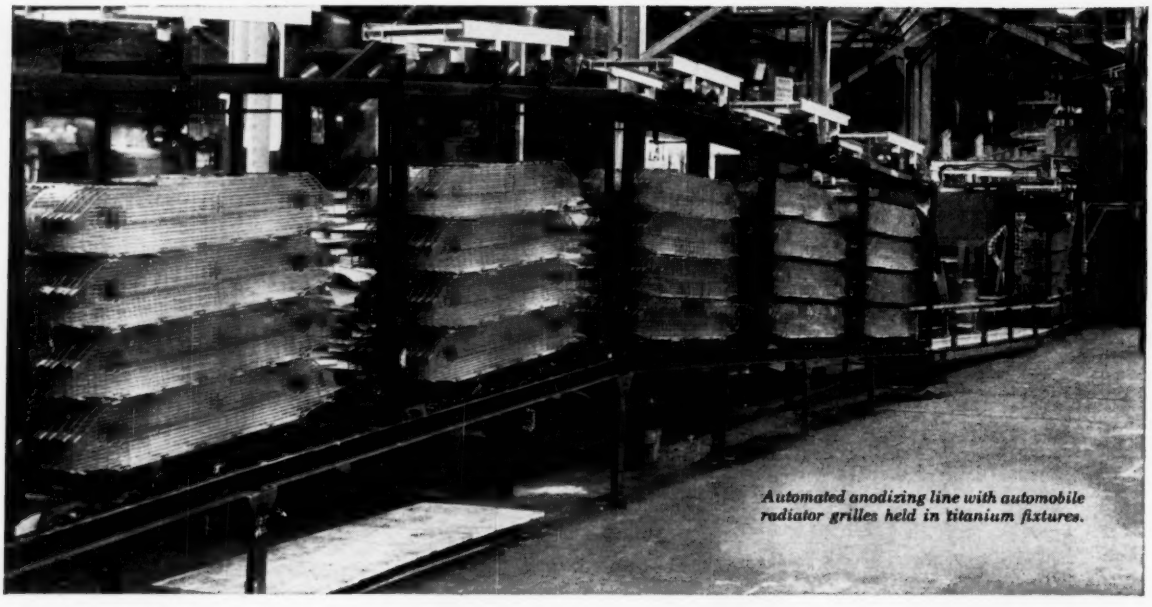
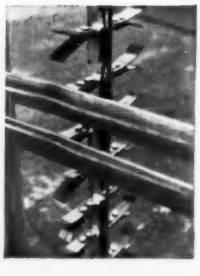


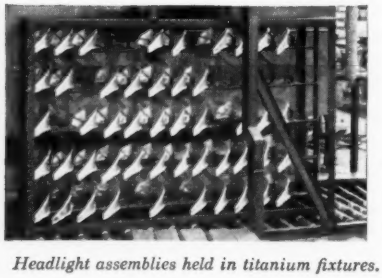
Automated anodizing line with automobile radiator grilles held in titanium fixtures.

TITANIUM LASTS 20 TIMES LONGER

in this anodizing process



Close-up of moldings held in titanium tips on anodizing rack.



Headlight assemblies held in titanium fixtures.

This automatic anodizing line at Reynolds Metals Company, Louisville, Kentucky, handles aluminum automotive parts on a huge scale. Parts such as window frames, grilles, hood moldings and headlight assemblies, are mounted on racks, which are first dipped in a brightener solution (highly concentrated sulfuric and phosphoric acid), then into an electrolytic bath.

What metal should be used to make the racks? Typical rack life at Reynolds was only 6 days on one anodizing line until titanium was tried. Average rack life is now *120 days*.

For economy in construction, the basic racks are made of aluminum, which is rubber coated. The rack tips or holding fixtures, which must be left bare, are made of Mallory-Sharon commercially pure titanium, riveted or welded in place.

Titanium in this mass production operation yields substantial savings, prevents the disruption of constant replacements. Let us help *you* evaluate titanium wherever you have the problem of corrosion. Write for booklet listing titanium corrosion-resistance data.

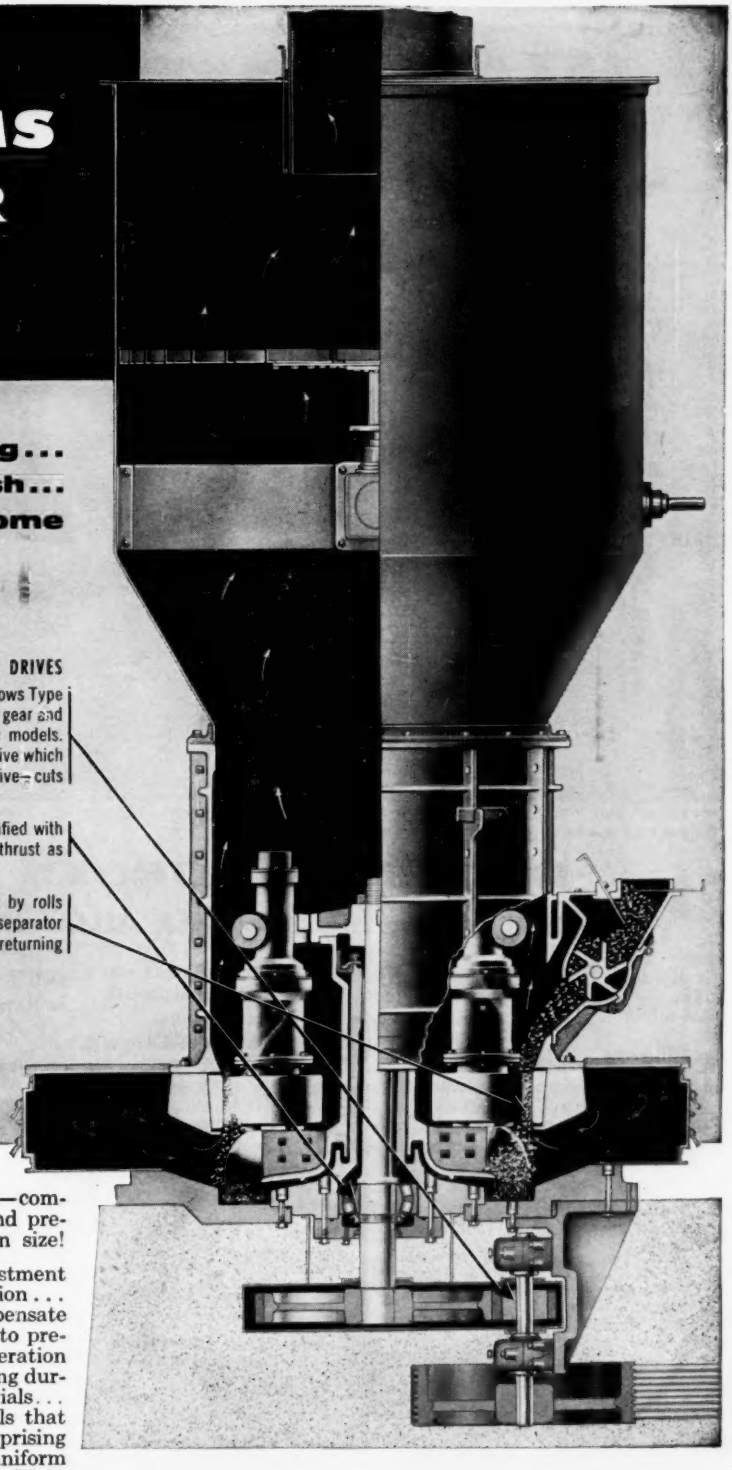
MALLORY-SHARON

METALS CORPORATION • NILES, OHIO

See our 4-page ad in Chemical Engineering Catalog, Pages 1147-1150, for additional technical information.

Integrated producer of Titanium • Zirconium • Special Metals

WILLIAMS ROLLER MILLS



- **Quality Fine Grinding... 20 Mesh To 400 Mesh... Micron Sizes On Some Materials**

EXCLUSIVE GEARLESS AND SPUR GEAR DRIVES

Another Williams advancement! Cutaway shows Type D Mill with Spinner Air Separator with spur gear and pinion drive used on Standard and larger models. Smaller sizes have simple gearless V-belt drive which is easier to maintain than bevel gear drive—cuts labor and downtime.

Bearing alignment of central shaft is simplified with only 2 bearings, the bottom one carrying thrust as well as radical load.

NOTE FLOW OF MATERIAL being ground by rolls rotating against bull ring, then air-swept to separator which discharges finished product while returning coarse tailings for regrinding.

From raw material to finished product—completely automatic grinding, blending and precision classifying to 20 mesh or micron size!

Self-adjusting feed rate . . . instant adjustment for sizing, even while mill is in motion . . . continuous automatic take-up to compensate for wear . . . constant rising air current to prevent build-up of fines and inefficient operation . . . automatically controlled hot-air drying during grinding of moisture-carrying materials . . . all are features of Williams Roller Mills that virtually guarantee increased output, surprising cost reductions and exceptionally high uniform quality. Get all the facts immediately . . . *Write today for catalog.*

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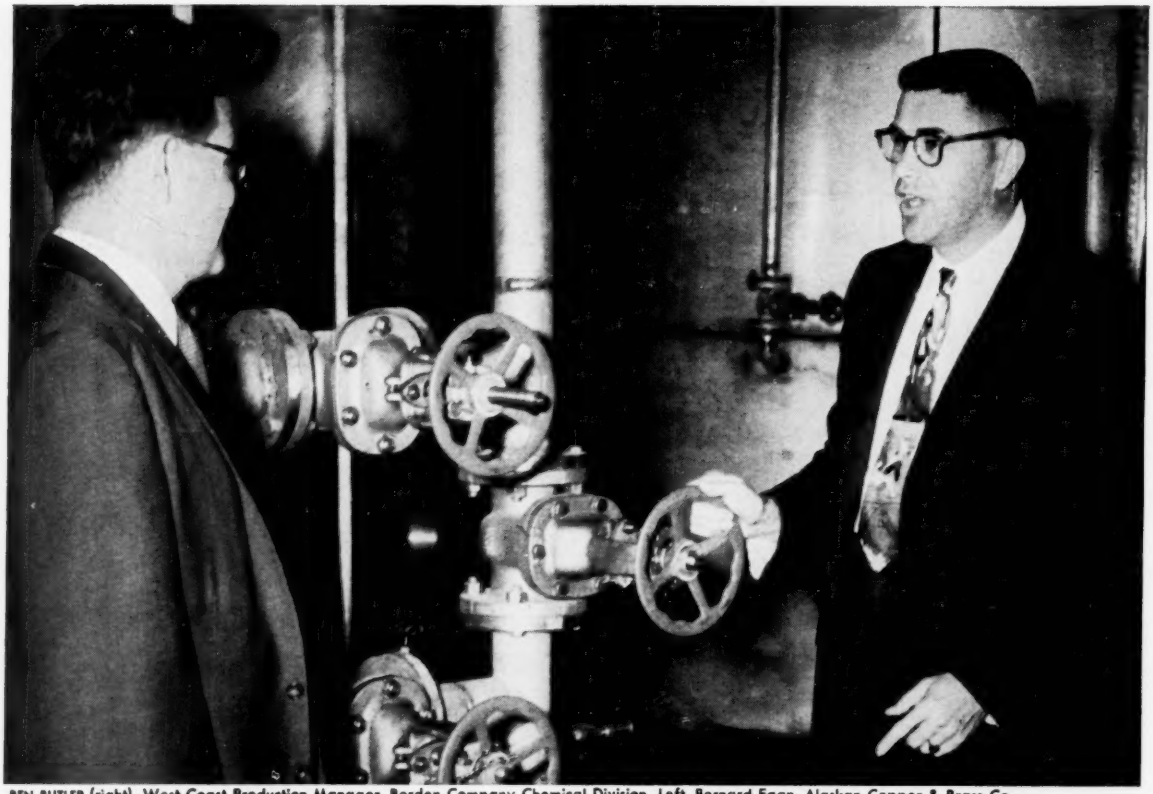
Oldest and Largest Manufacturers of Hammer Mills in the World



BEN BUTLER (right), West Coast Production Manager, Borden Company Chemical Division. Left, Bernard Egan, Alaskan Copper & Brass Co., Cooper Alloy distributor for the Pacific Northwest.

BUTLER OF BORDEN CHEMICAL

tells why he buys COOPER ALLOY stainless steel valves

Q. Mr. Butler, why does Borden Company Chemical Division require stainless steel valves?

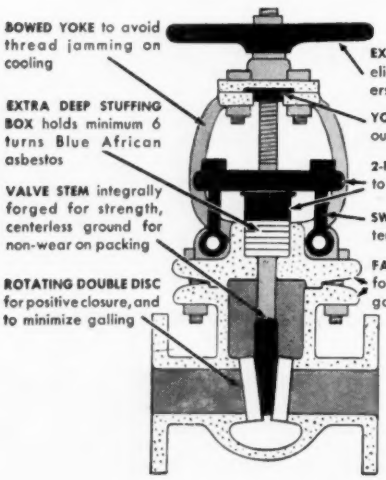
A. In the manufacture of formaldehyde, its derivative resins, and corresponding industrial adhesives only stainless steel can meet our rigid requirements for corrosion, contamination and heat resistance.

Q. What do you consider the most important factor in purchasing valves?

A. The truest measure of a valve is its operating performance. We have never received a complaint on Cooper Alloy valves from our engineers or operating personnel. The extra-large handwheel and unique valve design afford easy operation with positive opening and closing, minimizing maintenance and down time.

Q. What other factors count in choice of valve supplier?

A. Service. The large and complete Cooper Alloy stock at Alaskan Copper affords immediate delivery on stainless steel valves and fittings, as well as pipe. That's a big reason why we buy Cooper Alloy!


BOWED YOKE to avoid thread jamming on cooling
EXTRA DEEP STUFFING BOX holds minimum 6 turns Blue African asbestos
VALVE STEM integrally forged for strength, centerless ground for non-wear on packing
ROTATING DOUBLE DISC for positive closure, and to minimize galling
EXTRA LARGE HANDWHEEL to eliminate need for "persuaders"
YOKE NUT REPLACEABLE without valve disassembly
2-PC. GLAND CONSTRUCTION to prevent scoring of stem
SWINGING EYEBOLTS for maintenance convenience
FAIRED BODY-BONNET FLANGES for equal stress and uniform gasket loading

A VALVE DESIGNED FOR STAINLESS!

The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* **Check the Special Design Features shown at left.**

As the little CA man below is saying: *"You can tell a Cooper Alloy Valve as far as you can see it!"* Write today for *your* copy of our folder "Design Factors In Stainless Steel Valves." The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves *and fittings*, and their advantages. He can serve you promptly from local stocks.

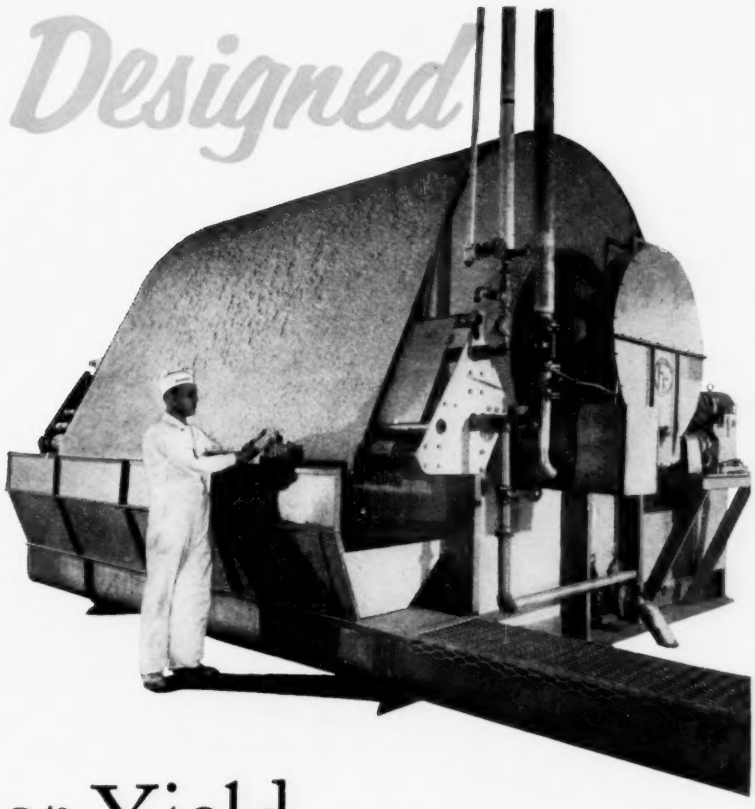
COOPER ALLOY

Corporation • Hillside, New Jersey

VALVE & FITTING DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING

Custom Designed



For a Bigger Yield

Higher yield in your case may mean cleaner, dryer cake . . . or better recovery of solubles . . . or just plain fast, trouble-free operation on a job that's got to be done. If you can get a few points better efficiency at no extra cost, why not?

FEinc custom-designed continuous vacuum filters have been doing just this for 37 years: For instance:

- Replaced six settling tanks in recovering plastic grinding waste . . . paid for itself in 3 months
- Reduced moisture in iron pigment from 68 to 59%
- Cut recycling of difficult gelatinous sulphate cake from nine to five cycles
- Eliminated plugging, gave three hours more running time daily on sticky clay
- Reduced solubles in metallic stearate from 0.5 to 0.05%
- Recovered ⅔ of chromates left by competitive filter

All types of continuous rotary vacuum filters . . . string, horizontal, scraper, precoat, etc. . . . are custom designed and manufactured by FEinc . . . quality built because quality pays you. Ask for bulletins . . . or for recommendations . . . no obligation, of course.

47 *See our insert in Chemical Engineering Catalog or write today*

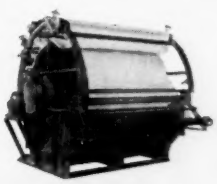
For a Bigger Yield

FE INC®

FILTRATION ENGINEERS

AMERICAN MACHINE AND METALS, INC.

EAST MOLINE, ILLINOIS



STRING

HORIZONTAL

SCRAPER

CUSTOM DESIGNED CONTINUOUS FILTRATION

need
steam traps?

name the way you want them!

TYPE A

TYPE D

TYPE C

Nicholson can supply your steam traps, exactly as you want them . . . for any service, any condition. Name the size, material, pressure, capacity you need. Types A, D, C are the ones you'll most likely use. Make your selection.

Sizes: A—from ¼" to 1". D—from ¼" to ¾". C—from ½" to 2".

Materials: Cast Iron, Cast Steel and Bronze.

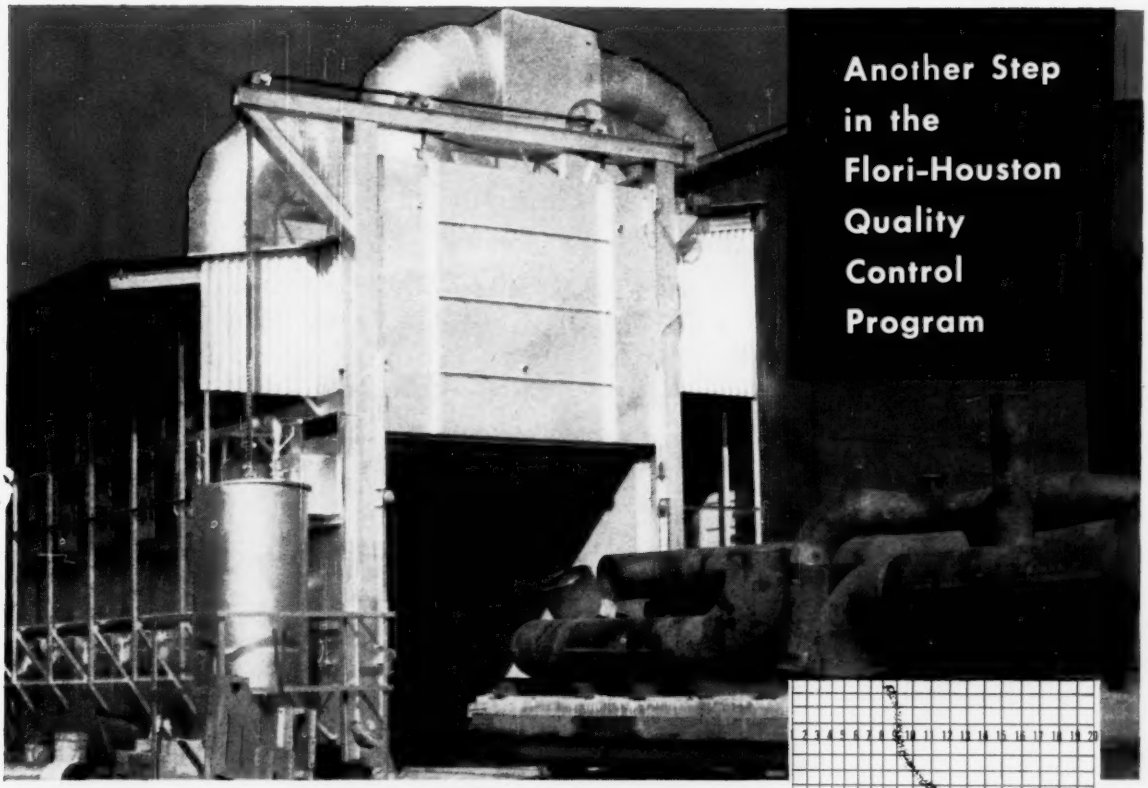
Pressures: A and D—Vacuum to 200 lbs. C—Vacuum to 300 lbs.

Capacities: From two to six times greater orifice area and capacity than other traps of comparable size.

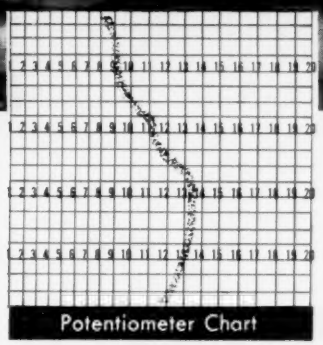
Why wonder about your steam traps . . . when you can get Nicholsons exactly as you need them for your own applications. Nicholson traps are simple in design, have only one moving part . . . a valve that discharges condensate and prevents steam loss.

You get faster warmup, with high air-venting capacity. You eliminate costly leakage, with a powerful shut-tight valve action. You get a trap that's service-tested, when you specify Nicholson. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and engineering offices in 98 principal cities.

NICHOLSON
of Wilkes-Barre



Another Step in the Flori-Houston Quality Control Program



Potentiometer Chart

FLORI-HOUSTON'S Custom Stress Relieving

means better pipe fabrication...

In this new 14-point heat controlled stress relieving furnace, all piping welds are stress relieved to your exact specifications. Temperature of the work during the carefully controlled heating and cooling cycle is checked continuously with as high as 12-point recording and controlling instrumentation. Furnace gas temperatures are zone controlled and recorded. Potentiometer Charts showing the exact heat treating cycles are always furnished assuring you of longer life and better performance from your piping.

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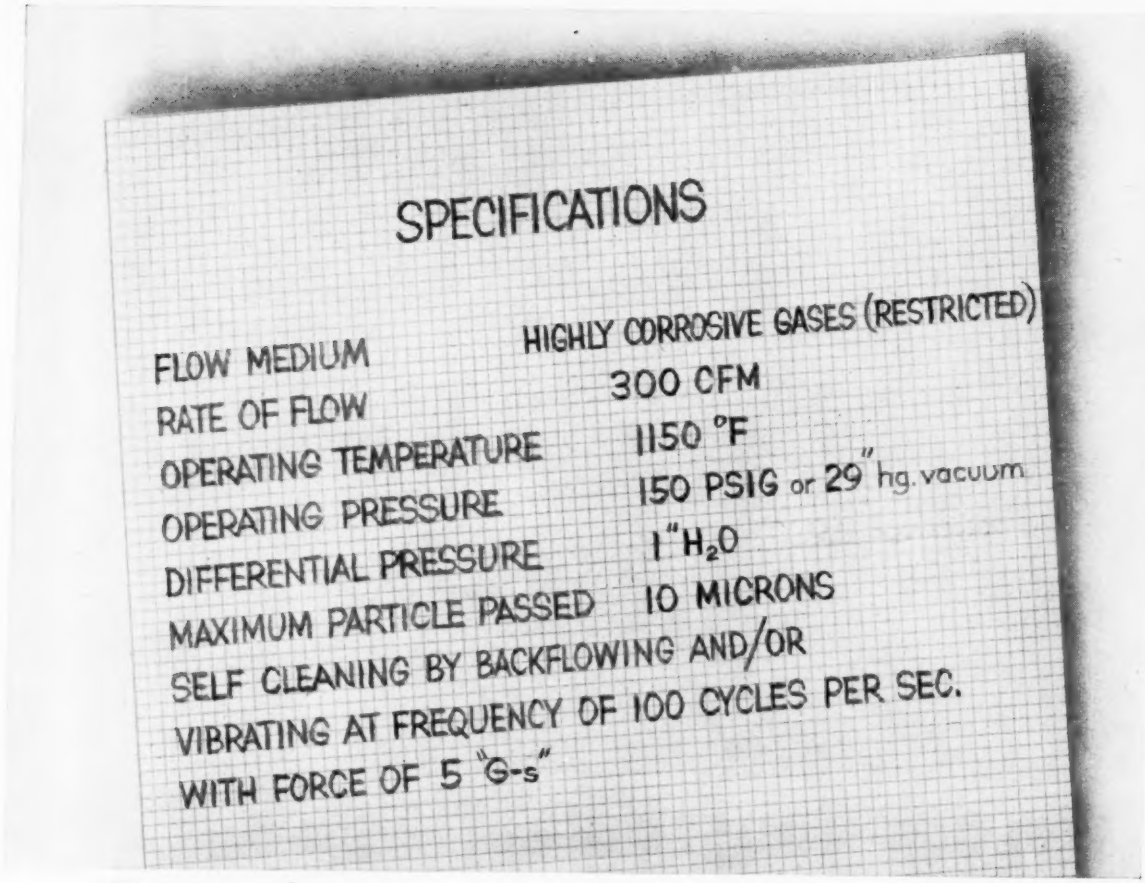
FREE.....

Handsome illustrated brochure showing Flori-Houston's complete facilities, fabrication processes, and outstanding examples of Flori-Houston fabrication jobs. Write today for your copy.



Do you have filtration problems as tough as this?

PUROLATOR'S ENGINEERING SALES STAFF WILL HELP YOU SOLVE THEM

The requirements above are not hypothetical . . . they are typical of specifications to which Purolator has designed and built filters. The filtering elements designed for this application combine two forms of a porous metal media to obtain the required filtration qualities with the structural strength needed to withstand the punishment of the self-cleaning action – plus the temperature gradients and the effects of corrosive materials.

Purolator's engineering staff specializes in designing and building filters for difficult applications like this. The emphasis is on engineering, by a staff of "Q" and "L" cleared filtration experts, backed up by complete manufacturing facilities, able to produce filters or separators of any known media to operate within these wide ranges of conditions:

TEMPERATURES: from —420° to 1200° F.

PRESSURES: from a nearly perfect vacuum to 6,000 p.s.i.

RATES OF FLOW: from drop by drop to thousands of GPM.

DEGREES OF FILTRATION: from submicronic to 700 microns (in various media).

This complete filtration service, for the toughest problems in nuclear and chemical applications, is available only at Purolator. Purolator's engineers are ready to work on your requirements. If you have an *urgent* need for specially designed filtration systems, call Jules Kovacs, Vice President in charge of Research and Development and Product Application . . . or send him the details of your application.

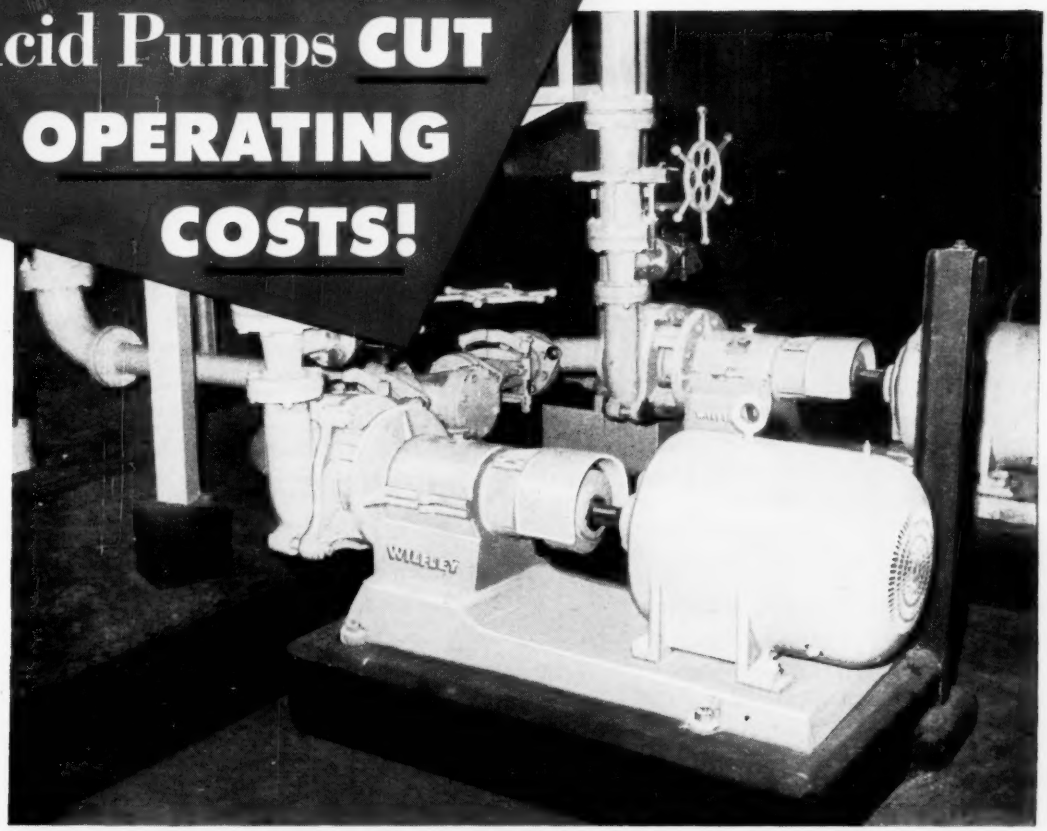
Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

RAHWAY, NEW JERSEY AND TORONTO, ONTARIO, CANADA

WILFLEY
Acid Pumps CUT OPERATING COSTS!



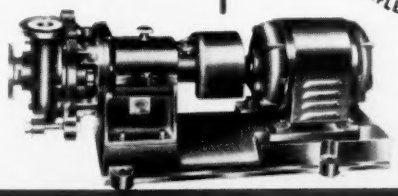
The reason... Dependability

Whenever Wilfley Acid Pumps are put to work, even on the most difficult applications, operating costs go down. These highly efficient pumps operate continuously without attention—eliminate costly maintenance. Wilfley dependability will save you money. Write, wire or phone.

Individual Engineering
ON EVERY APPLICATION

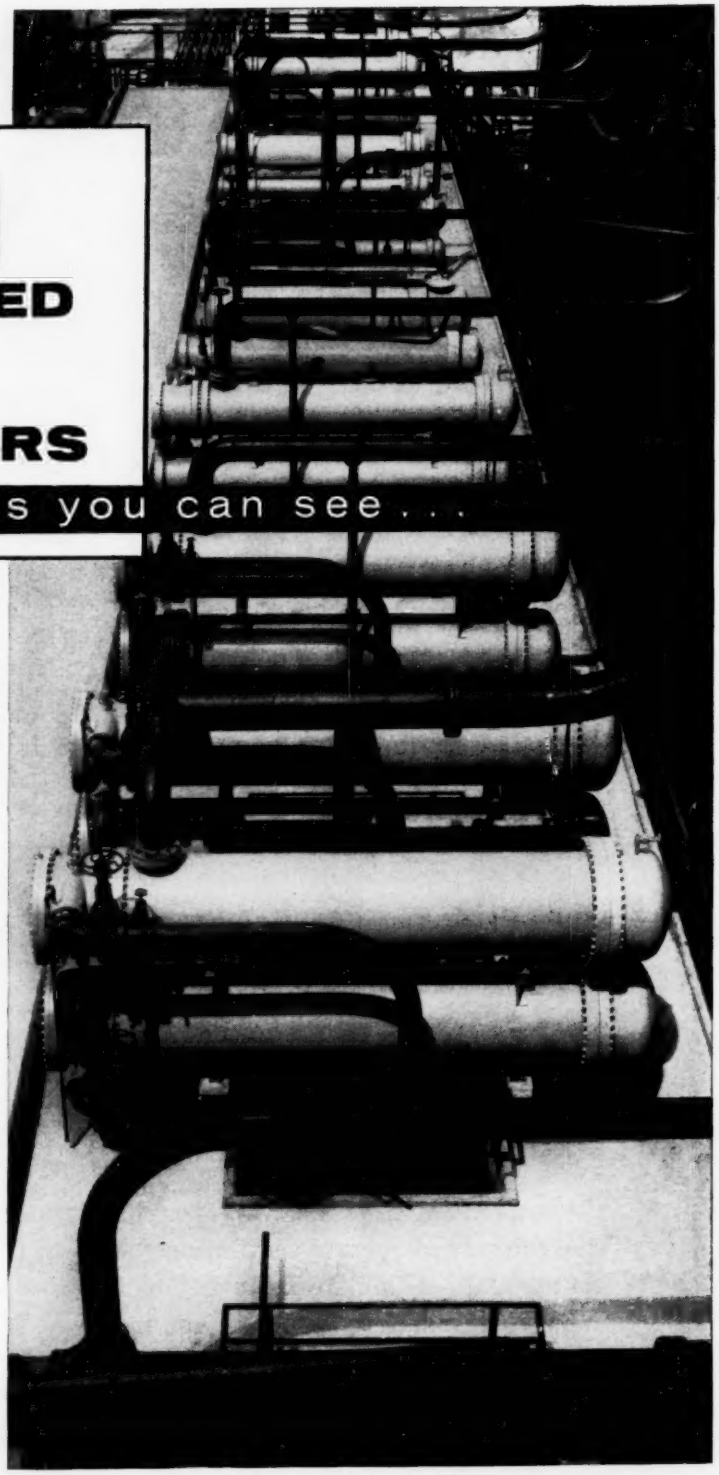
Wilfley Acid Pumps are available with pumping parts of the machinable alloys as well as plastic to meet all requirements.

WILFLEY ACID PUMPS
"COMPANIONS IN ECONOMICAL OPERATION"
WILFLEY SAND PUMPS



A. R. WILFLEY and SONS, INC.
DENVER, COLORADO, U.S.A. NEW YORK OFFICE: 122 EAST 42nd ST., NEW YORK CITY 17

YUBA
ENGINEERED HEAT EXCHANGERS
as far as you can see . . .



. . . and what you see is still only a fraction of the more than 100 heat exchangers giving trouble-free service in the high octane plant of the Continental Oil Co. at Ponca City, Okla. The Yuba units in this refinery have a total of 140,418 sq. ft. of heating surface.

Heat exchangers for petroleum refineries and for chemical plants can be built with Yuba's well-known *Multilok Closure* to handle volatile fluids at 1200 F and pressures at 6000 psi and higher. Heat exchangers in lower pressure-temperature ranges, where leakage is not a problem, have standard bolted flange construction.

Yuba's ability to outfit a process or an entire plant with heat exchange equipment is one of its outstanding accomplishments. Yuba's design efficiency helps a petroleum or chemical plant to achieve maximum heat economy and, as a result, helps it to lower its manufacturing costs significantly.

Consult Yuba on your next heat exchanger order. You will find its East-West manufacturing and sales facilities very convenient.

YUBA CONSOLIDATED INDUSTRIES, INC.

Divisions Manufacturing Heat Exchangers
YUBA HEAT TRANSFER DIVISION, HONESDALE, PA.
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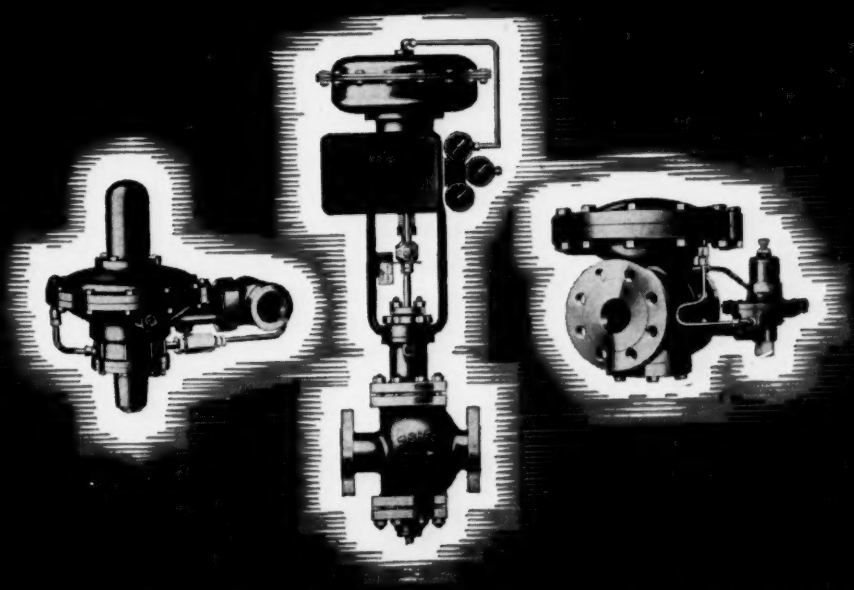
the tough Control Valve jobs go to



FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA • WOODSTOCK, ONTARIO

MICROAMMETER-MILLIVOLTMETER RECORDER PERFORMS 6 FUNCTIONS

1. **Measures low-level dc signals with calibration accuracy within 0.5%, and sensitivity within 0.2% of span.**
2. **Records on 3" continuous strip chart or IBM-type card chart, with linear coordinates.**
3. **Positions recording pen with force many thousand times greater than usual direct-deflection electrical movements.**
4. **Operates on force-balance principle—compensates for ambient conditions, changes in power supply and components.**
5. **Records fast—up to 0.05 seconds for 63% of fullscale changes.**
6. **Provides span and zero adjustments for easy calibration and zero suppression in the field, without special equipment.**

For only $250—
A More Accurate
HIGH-SPEED MILLIVOLT RECORDER

This highly sensitive 'American-Microsen' Series 130 Recorder, with all its operational advantages, costs less than others designed for the same jobs. Simple design, precision components and rugged construction assure sustained high accuracy and freedom from maintenance. The recorder withstands shock up to 30 times gravity.

Since its introduction less than a year ago, the Series 130 Recorder has been very successful because it offers a more accurate and durable method of recording dc electrical signals at lower cost. It is being used to record outputs of many different electrical transducers – for measurement of such variables as pH, gas analysis, signal strength and others.

Many laboratories have adapted the Series 130 Recorder to their analytical and scientific instruments to assure accurate, permanent records of results which previously were only indicated. The Recorder can be used with any device which can provide 200 microamperes or more in its output circuit.

Standard 'American-Microsen' Series 130 Recorders are priced at $250.00. All models have ample power to operate alarm contacts which can be supplied at extra cost. *Write for Bulletin MG10.*

SPECIFICATION BRIEFS

POWER SUPPLY: 115 volts, 60 cycles. **POWER REQUIREMENT:** 9 watts.
INPUT RANGES: Voltage – 0-20 millivolts to 0-100 volts dc. **Current** – 0-200 microamperes to 0-100 milliamperes dc. **Input Sensitivity** – 6700 ohms per volts.
ACCURACY: ± 0.5% of span. **SENSITIVITY:** ± 0.2% of span.
REPEATABILITY: ± 0.25% of span.
EFFECT OF SUPPLY VOLTAGE: Less than 0.5% error 90-130 volts.
EFFECT OF AMBIENT TEMPERATURE: Less than 0.5% error 50° to 100° F., and less than 1% to 130° F.

RESPONSE TIME: Fast Speed – 0.2 seconds standard for 63% of fullscale input change; up to 0.05 seconds for 63% on special order. **Slow Speed**– approximately 4 times fast speed setting.
CHART SPEEDS: Strip Chart – 1" per hr., standard; 3" or 6" per hr. available. **Card Chart** – 1 rotation per day, standard.
SPAN ADJUSTMENT: ± 10% of span. **ZERO ADJUSTMENT:** ± 100% of span.
PANEL SPACE REQUIRED: Only 27 square inches.

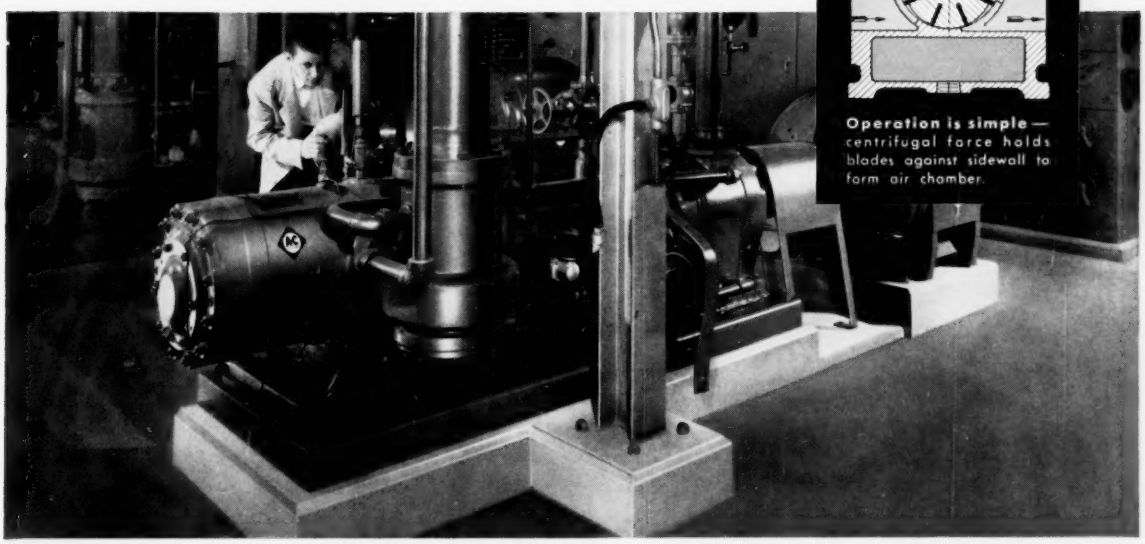
MANNING MAXWELL & MOORE INC. TRADE MARK

MANNING, MAXWELL & MOORE, INC.
INDUSTRIAL CONTROLS DIVISION · DANBURY, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

MI-58

Ro-Flo COMPRESSORS



Operation is simple—centrifugal force holds blades against sidewall to form air chamber.

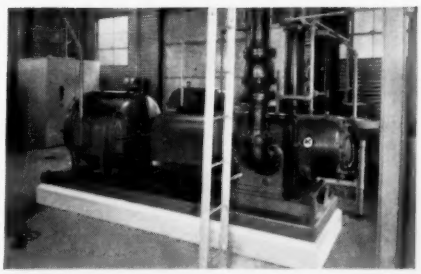
Ro-Flo units at a Midwest utility supply air for mixing with vaporized propane gas to meet an increased demand for natural gas.

No shake...no shimmy...no shock!

Rotary operation produces a remarkably stabilizing effect. You don't get the shimmy and shock inherent in reciprocating compressors.

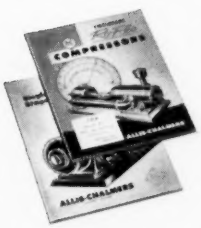
Users in many industries have discovered that *Ro-Flo* compressors eliminate the cost of heavy foundations. A simple slab is enough. Smaller units are bolted directly to the floor. Automatic wear compensation at the rotor blades keeps compressor efficiency at high level even after years of use. There are only two wearing parts.

Ratings—Choose from twelve sizes of two-stage *Ro-Flo* compressors, ranging from 250 to 1800 cfm at pressures from 60 to 125 pounds gauge. Single-stage *Ro-Flo* units handle pressures up to 50 pounds gauge, and handle volumes from 40 to 3000 cfm.



Two-stage *Ro-Flo* compressor, installed in natural gas pipeline booster station. Unit provides make-up gas to help maintain line pressure for peak loads.

Mobile *Ro-Flo* compressors used on emergency equipment for fighting oil tank fires at a Texas oil storage area.



For complete information on Allis-Chalmers rotary compressors, ask for two-stage Bulletin 16B8244 or single-stage Bulletin 16B8126. Call your nearby A-C office or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.

Ro-Flo is an Allis-Chalmers trademark.

ALLIS-CHALMERS

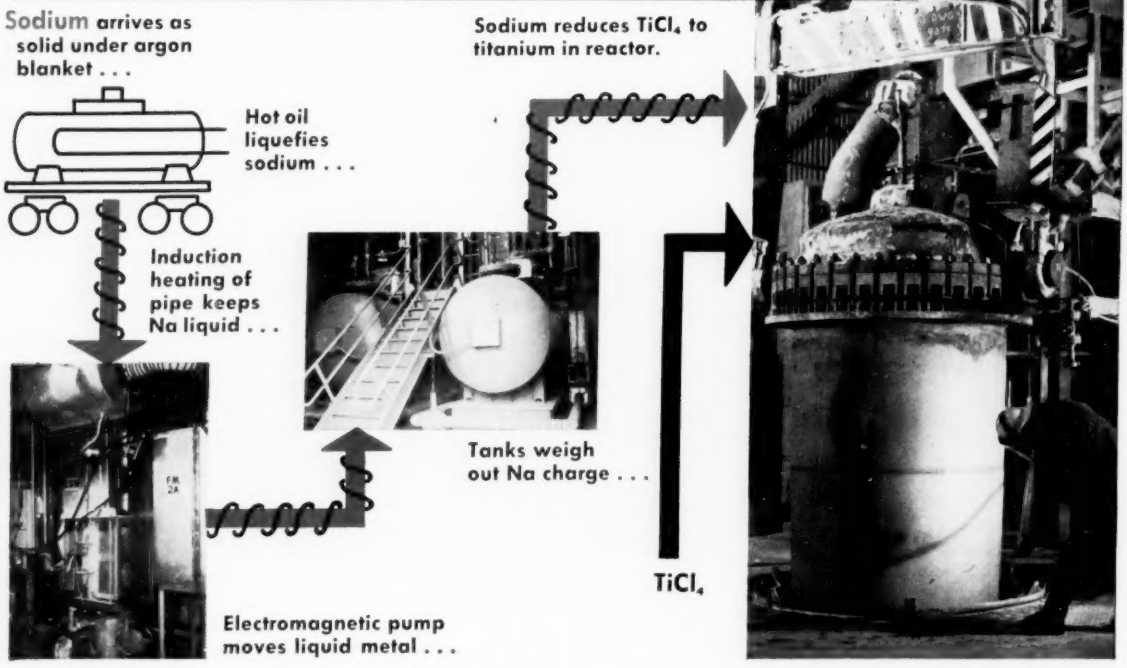
A-C ALLIS-CHALMERS

A-5610

PRACTICE . . .

PROCESS FLOWSHEET

BY T. PETER FORBATH


Sodium arrives as solid under argon blanket . . .
Hot oil liquefies sodium . . .
Induction heating of pipe keeps Na liquid . . .
Sodium reduces $TiCl_4$ to titanium in reactor.
Tanks weigh out Na charge . . .
$TiCl_4$
Electromagnetic pump moves liquid metal . . .

Processing With Sodium Poses Chief Engineering Challenge

Sodium-Reduction Route Yields Titanium

WORKING with sodium, even on a lab bench, rates as pretty tricky business. But when it comes to processing with the reactive alkali metal on a thousands-of-tons-per-year basis, some unusual and imaginative engineering is critically called for.

At Electro Metallurgical's $31.5-million titanium plant in Ashtabula, Ohio—now freed of security wrappings for the first time—that's just the case. For there, Electromet has turned away from the well-established Kroll-magnesium route to titanium and pioneered commercial production of titanium sponge via sodium reduction of titanium tetrachloride.

Electromet's flowsheet, swung on stream initially in April 1956 and stepped to its full potential that December, demands sodium on a scale that makes the company one of the most extensive "processors-with-sodium" around. For example, when operating at its full capacity of 7,500 tons/yr.* the Ashtabula installation consumes roughly 18,000 tons/yr. sodium.

▶ **Moving Na Into Action**—Electromet receives its large quantity of sodium from National Distillers & Chemical as a solid, shipped under an argon blanket in 80,000-lb.-capacity railroad cars. Electromet's challenging task: To liquefy the metal and keep it liquid while transporting it to the $TiCl_4$ reduction stage. Here's how the job's handled:

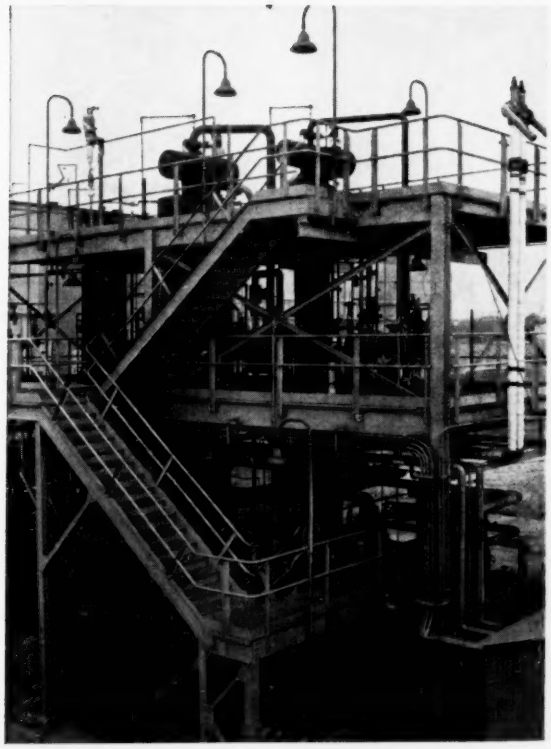
To initially melt the sodium (m.p. 97 C.), Electromet circulates heating oil at 120 C. through channels in the railroad car. Then the car is pressurized to about 15 psig. with argon to prime sodium pumps—conduction-type electromagnetic pumps manufactured by Callery Chemical. These units provide a 30-psi. head and "push" the sodium along at the rate of 40-50 gpm. via the electromotive force that's developed by passing an electric current through the sodium at right angles to a magnetic field.

Sodium travels to the reduction reactors through some 4,000 ft. of 2-in. carbon steel pipe. To keep the metal liquid during this journey, Electromet has equipped the entire length of piping with induction-heating coils and magnesia insulation. Induction rather than resistance heating was chosen, points out Titanium Plant Superintendent Jack Winterhaler, for its ease of installing and maintenance.

To insure that a pure sodium stream enters the reactors, Electromet fitted special stainless steel, micrometallic filters in the pipeline to remove sodium oxide and other impurities.

*Currently, due to government titanium-order cutbacks, Electromet is running at about 25% of capacity.

Unfold Flowsheet



1 DISTILLATION COLUMNS cut out impurities in $TiCl_4$ introduced by moisture and oxygen from air.

2 COOLING STATION: Cold air is blown around 14-ft.-by-5-ft. reactor for about three days.

▶ **For Pure Sponge, Pure Tickle**—Too, Electromet gives close attention to its other chief raw material—the titanium tetrachloride purchased from Columbia-Southern. In shooting for top purity titanium sponge, Electromet must start out with high purity $TiCl_4$, stresses Ashtabula Plant Manager Milton J. LeRoy.

"Tickle" (industry parlance for $TiCl_4$) is sent through a purification stage, and is always handled and transported under inert-atmosphere blankets. Reason: Tickle picks up oxygen and moisture with distressing ease, so becomes contaminated with such impurities as titanium subchlorides and suboxides, hydrochloric acid, water, etc. And, unless removed, these will damage final sponge purity.

Raw tickle, from 40,000-gal. storage tanks, is distilled in a Raschig-ring-packed, 40-ft.-tall by 3-ft.-dia. column. Bottoms stream from this column goes to a 40-ft.-tall by 4-ft.-dia. York-mesh-packed distillation column which delivers, as overhead, refined $TiCl_4$ to argon-blanketed storage tanks. Overhead of first column and bottoms of second, both impurities streams, go to a batch still where a raw tickle stream is recovered and recycled to join fresh feed to first column.

Final distillation tower operates under argon atmosphere to prevent oxygen and water pickup by tickle. And hot and cold oil rather than steam and water are used in all the columns' reboilers and condensers to guard against water contamination at these process points.

▶ **Two Parallel Lines**—Electromet's plant consists of two identical, parallel flowsheets, each housed in separate buildings. A sodium tank car pulls up to each building; refined $TiCl_4$ feeds both from the single refined-tickle farm.

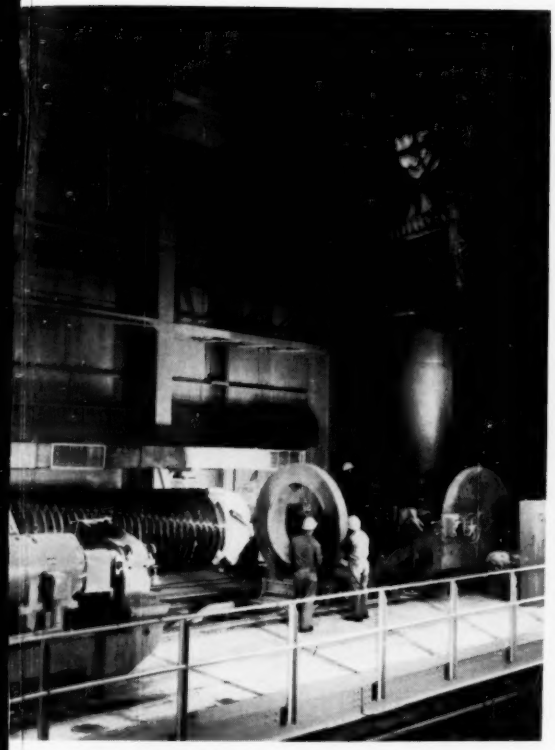
These raw material streams first go to weigh rooms; six to a building, each housing two mild steel tanks for sodium and two for tickle. One sodium tank weighs out roughly 4-5,000 lb. Na; one tickle tank weighs out 8-10,000 lb. $TiCl_4$; and together they represent the charge to one reduction-reactor station. Thus the six weigh rooms per building serve 12 reduction stations.

Each reduction station consists of a furnace and reactor. Furnace, a 20-ft.-deep by 8-ft.-dia. steel shell lined with refractory brick, is equipped, circumferentially, with Nichrome heating elements. Reactor, a stainless-steel-clad steel pressure vessel with 1-in.-thick walls, 14 ft. tall by 5 ft. dia., is first evacuated to under 300 microns by a four-stage stream ejector and backfilled with argon, then lowered into the furnace.

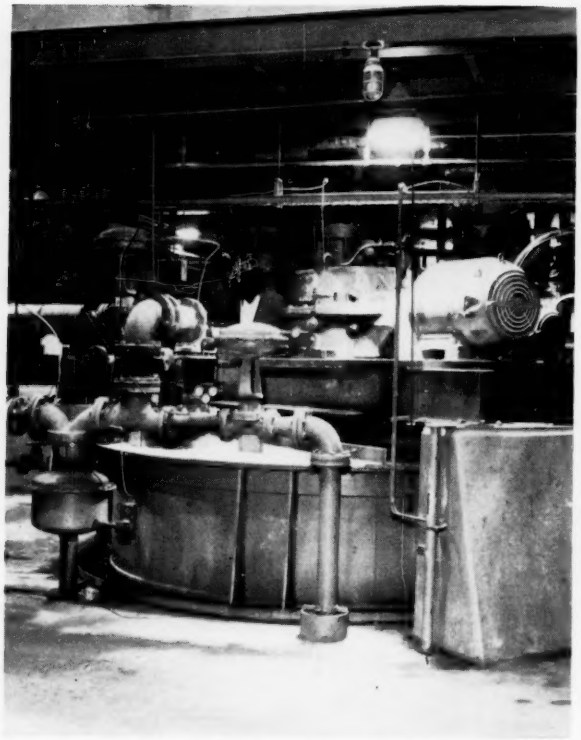
▶ **Reaction, Cookup, Cool**—Weigh tanks discharge Na and tickle simultaneously and continuously into the reactor. Reduction reaction, highly exothermic, proceeds for about 5-7 hr. without external heating. Then, to push the reaction to completion, the furnace comes into action to heat reactor to about 1,000 C. in a final 4-to-6-hr. "cook-up" period. About 1 ton of titanium is produced per reactor.

Still in the furnace, the reactor is allowed to cool for some 2-4 hr. From there it's carried by an overhead crane to a cooling well. There, air is blown around the reactor for roughly three days to complete cooling cycle. In the winter, the hot air from this station goes to help heat the plant building, other times it's simply vented.

▶ **Cut Out Spalt**—At this point, reactor contains a solid mixture of titanium sponge and sodium chloride, tagged "spalt." A horizontal boring machine,



3 SPALT REMOVAL: Horizontal boring machine (left) cuts out solid mixture of Ti sponge and NaCl.



4 LEACH TANKS: Slightly acidic (HCl) water leaches impurities from Ti sponge in rubber-lined tanks.

5 CEN
spon

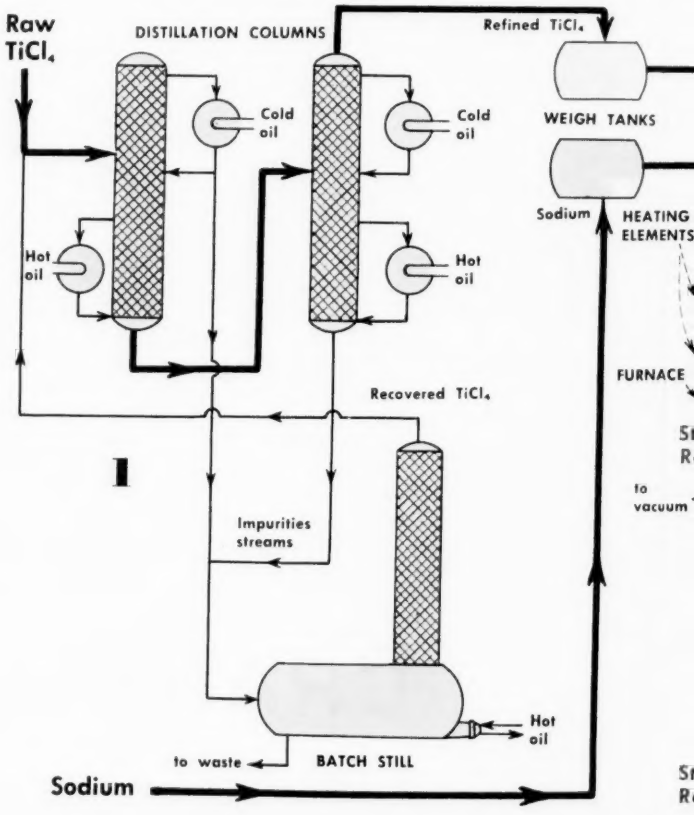
equipped with tool steel bits followed by a screw conveyor, cuts out the spalt, discharging it to 5-ft.-dia. by 6-ft.-high skips. Three skips, each holding some 4-5,000 lb. of spalt, are needed per reactor.

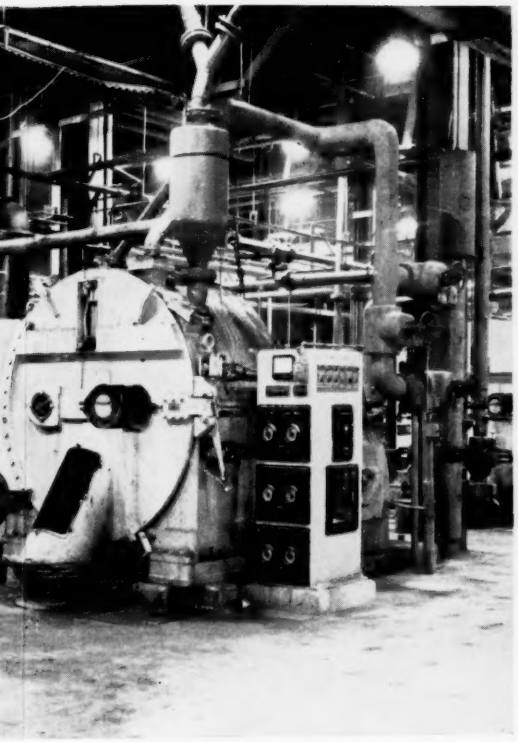
Skips feed through a vibrating screen, equipped with a magnet to remove iron that may have been cut out of the reactor by the boring machine, to a swing-hammer mill. Material ¾ in. dia. discharges from mill to a 13-ft.-high by 8-ft.-dia. skip that goes to leaching stage; oversize spalt recycles through the mill.

▶ **Leach and Dry**—Electromet runs 6 parallel-hooked, rubber-lined, agitated leach tanks, 11 ft. deep by 10 ft. dia. Spalt from one skip feeds one tank, discharging into it in about 20 min. There, about 5,000 gal of acidic (HCl) water has already been added. Leaching is continued for about 30 min. after these streams have been introduced. NaCl dissolves in water. Hydrogen, generated by reaction of any unreacted sodium in spalt with water, is vented. Suboxides and subchlorides of titanium, tied up by HCl, are removed from titanium sponge.

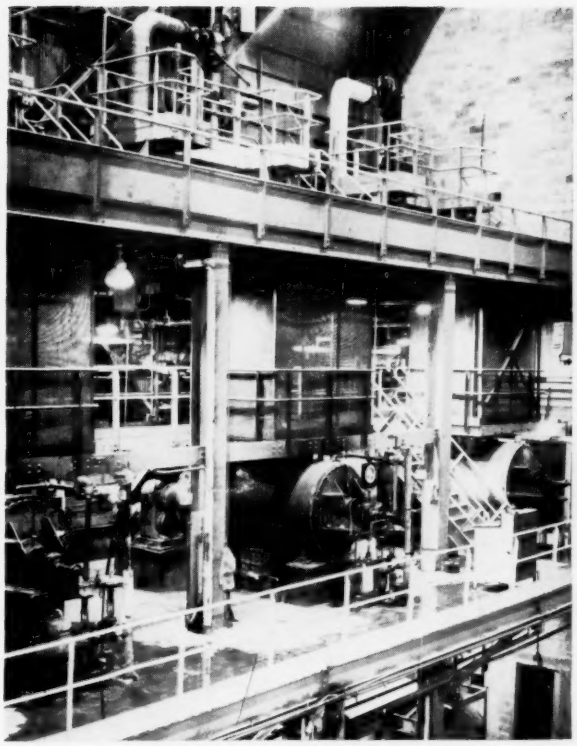
Stream feeds to a 60-in.-dia. horizontal basket centrifugal, one per two leach tanks, where brine is separated from sponge. Then sponge goes to one of four 10-ft.-long by 5-ft.-dia. jacketed horizontal vacuum (1 psia.) dryers. These units are equipped with 24-in.-dia. hollow shafts, on which rabble arms are fitted to stir the sponge. During a 2-hr. cycle, steam passes through the shaft and jacket to dry sponge. Then water passes through them to cool the material.

Dryers' vacuums are broken with nitrogen or argon and sponge is carefully blended with material from five other reactors to prepare large lots of uniform quality for market.



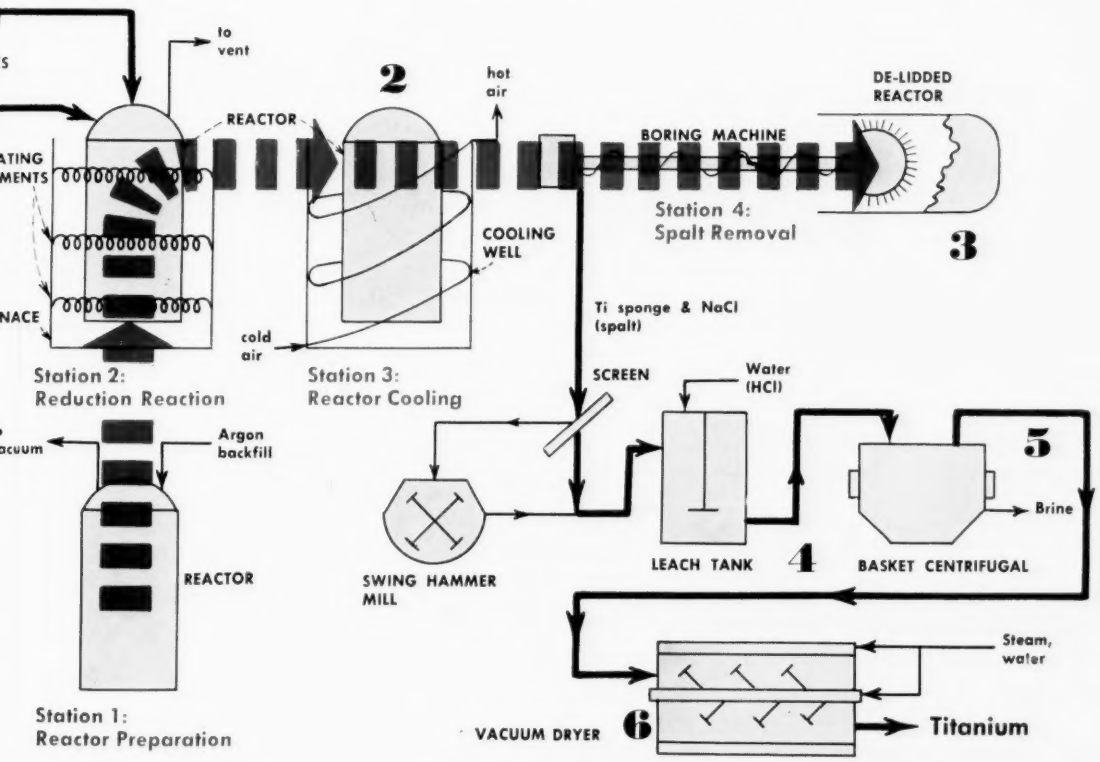


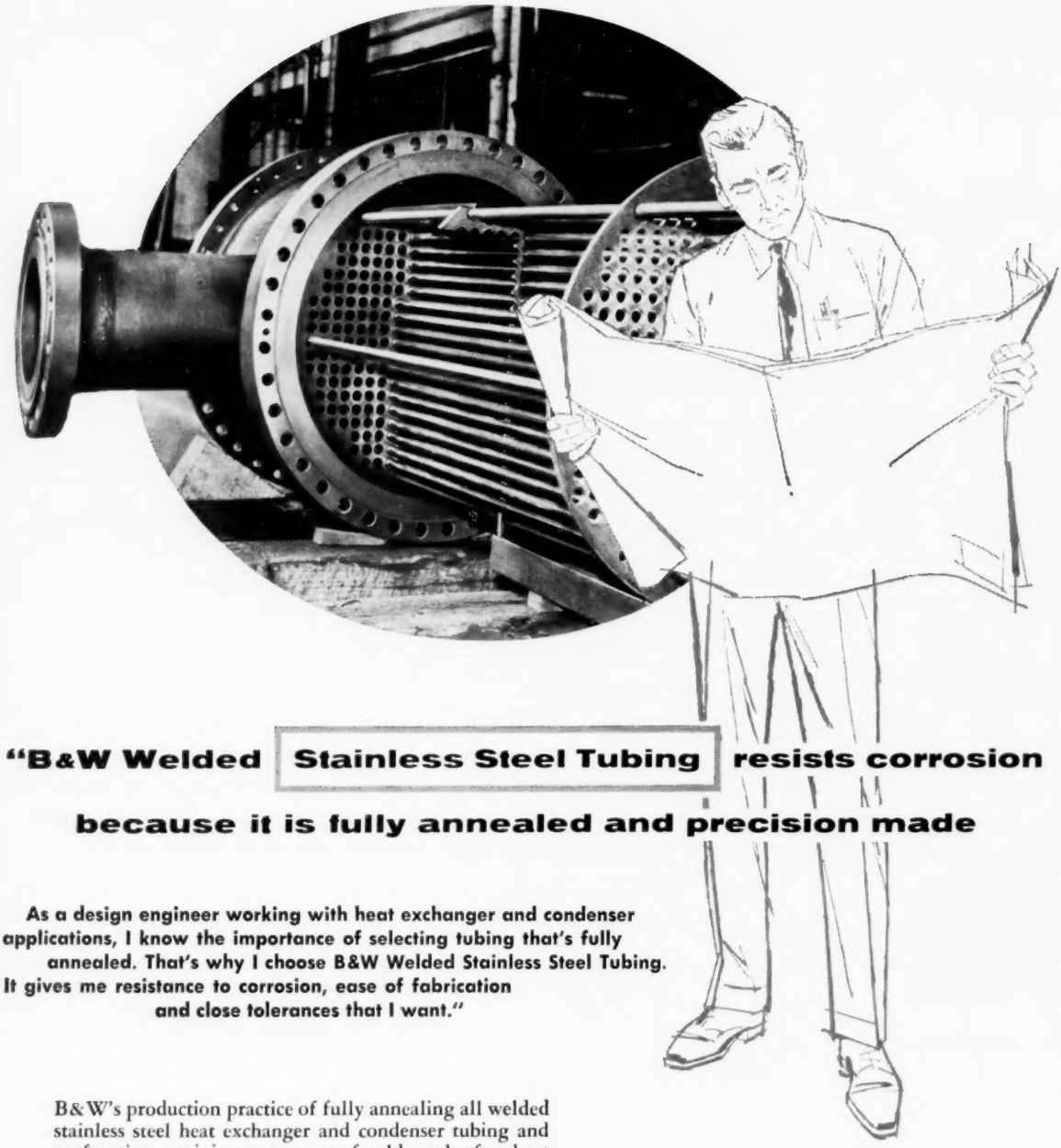
CENTRIFUGAL: Brine is separated from titanium sponge in these 60-in.-dia. horizontal basket centrifugals.



6 VACUUM DRYER: First steam, then water passes through dryer jackets to dry and cool titanium sponge.

Reactor Is Carried Through Four Stations





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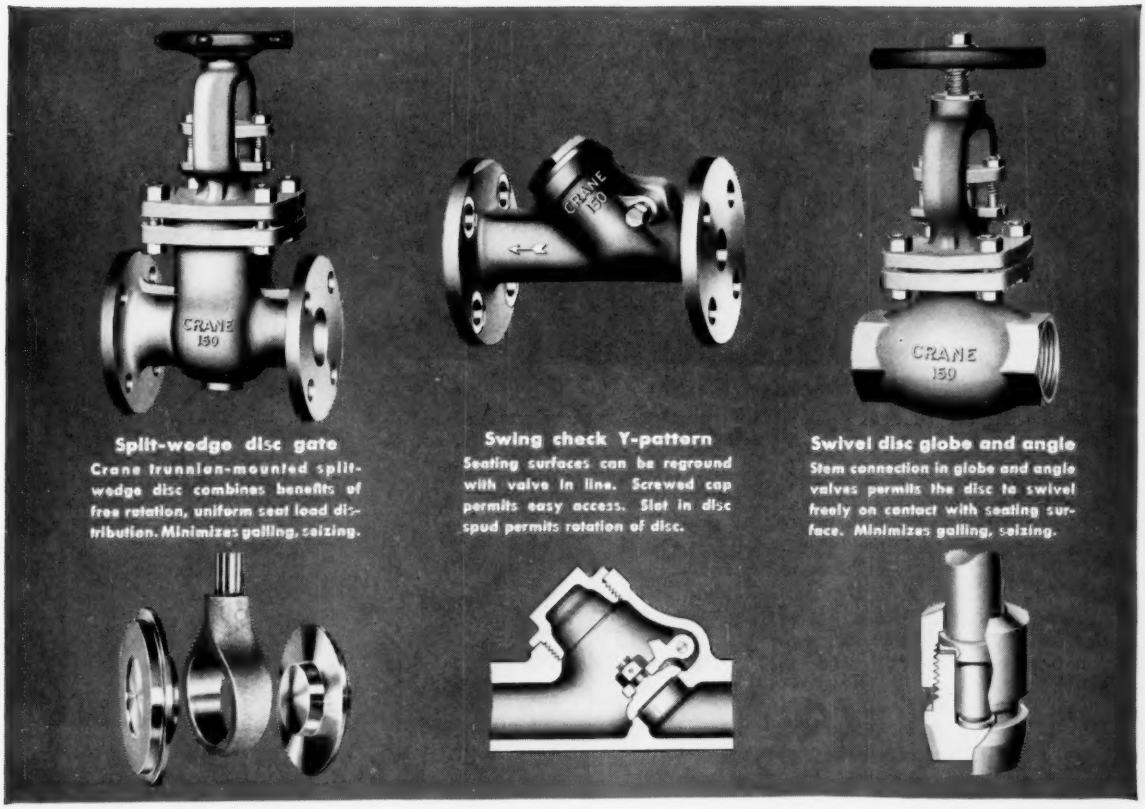

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Electromet turns its back on the usual Kroll-magnesium route to titanium by kid-gloving a touchy chemical wildcat —thus meeting a mighty tough engineering challenge.

What's ahead for atomic power? 133

Projecting the future of nuclear power is no snap assignment. Here are some realistic forecasts which should help clear away some of the prevailing pessimism.

New horizons for vertical pumps 139

Today, because of the many new demands on pumps, engineers are taking a second look at this one-time, not particularly versatile item—now dressed up in new refinements.

Are you a glutton for mathematical punishment? 143

Figuring out what kind of heat exchanger you need can be a pretty grueling affair. Since equations often repeat from one job to the next, why not hire a computer?

How to find heat of fusion and sublimation 147

Here are methods to help you calculate the latent heat of fusion and sublimation. Use these dependable methods. They're sure to save you much time and money.

Designing condensers to handle non-condensibles? . . . 150

Be sure to give this "do-it-yourself" nomograph a try. It'll eliminate those messy trial-and-error solutions for condensate film temperature.

Find accurate process steam costs 152

These detailed techniques will help you to allocate accurate process steam costs. What's more, they'll help you compare unit costs of steam from various sources.

MARCH 10, 1958

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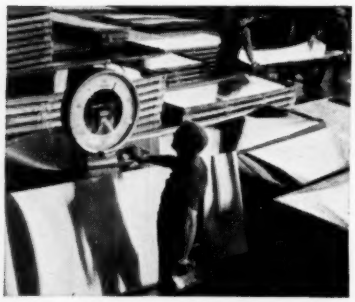

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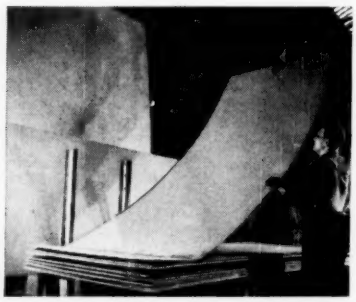

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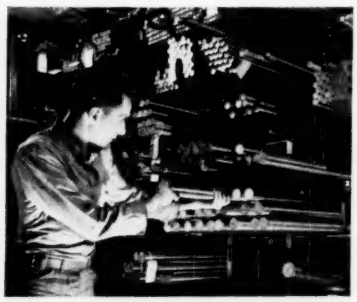

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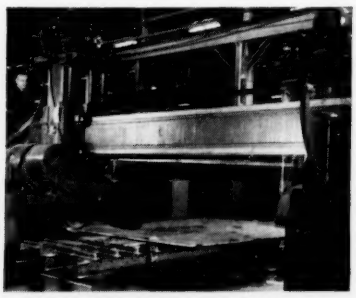

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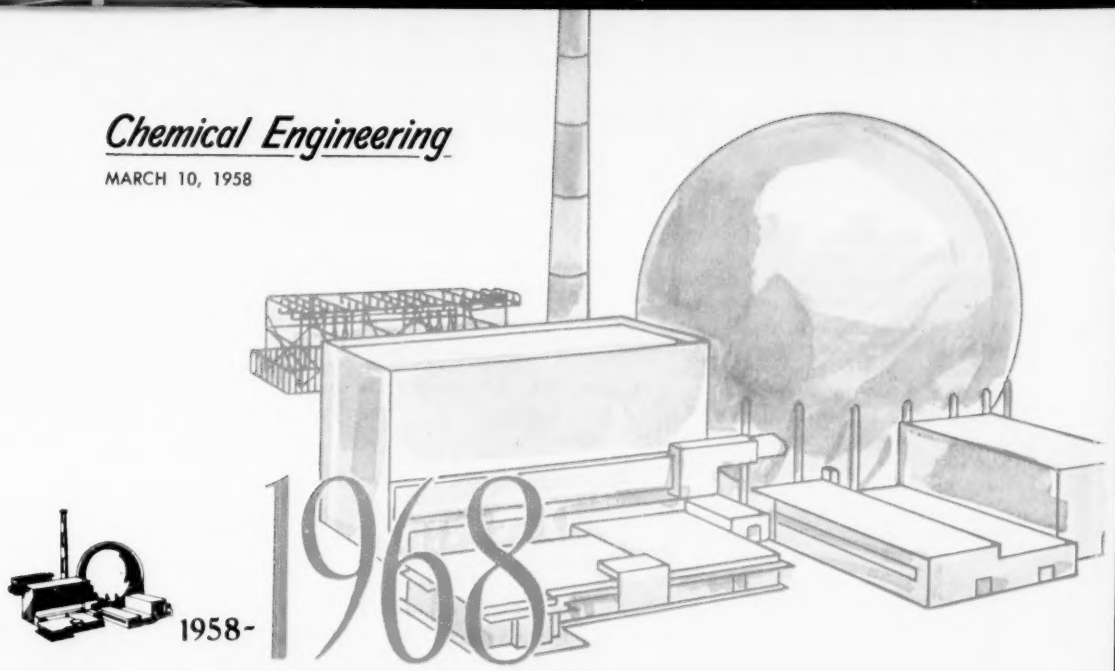
Chemical Engineering
MARCH 10, 1958



Pessimism's passé; we've a promising . . .

Nuclear Power Future

- Economic nuclear power should be here by 1965.
- Uranium supplies are plentiful.
- Reactor operating costs are coming down.

C. G. MANLY, Atomic Energy Commission, Wash., D. C.*

TODAY there is a feeling of pessimism in the commercial atomic energy field, much of it the result of errors in forecasting. These errors are not too surprising.

In atomic energy, the problems of forecasting and projection are extremely difficult. Early planners had to project a technological revolution with a very brief past. As planning goes, this is a narrow base on which to work. Generally, the narrower the base, the greater the chance for error. Now the base is somewhat broader.

This is a good time to take a realistic look at where atomic energy is going. Actually there are many reasons for optimism: our civilian reactor development program is coming along nicely, nuclear propulsion is developing rapidly, costs are dropping with experience, and uranium supplies are adequate. But we probably will not have economic nuclear power before 1965, and costs have to be reduced all along the line before the nuclear power industry really begins to grow.

Chemical engineers should be aware of what the future holds for nuclear power, for they will play a big part in this field. Only with this information can realistic plans be made technically and professionally.

Let's first look at the optimistic side of the ledger.

* Meet your author on page 185.

Enough Uranium Available

Ten years ago there was a shortage of known recoverable uranium reserves in the free world to supply military needs. The United States was considered a uranium-poor nation. Today we are wondering when

there will be a market for all the mined uranium.

Strangely enough, this fact goes into the plus, or optimistic, column. Widespread use of uranium depends on an adequate supply, readily available at a reasonable price. Without it the utility industry would be ill-advised to invest hundreds of millions of dollars in nuclear-electric power plants. Their practice is to amortize plants in about 25 years and to expect a useful life of about 40 years.

Nuclear power plants depend on fissionable material as fuel; they are not easily or cheaply converted to coal or oil. Before the utility industry can do more than explore nuclear energy, it must have assurance of adequate uranium reserves. Many utilities get assured supplies of coal by owning their own mines or coal deposits. We are taking a very important step toward bringing about nuclear power by finding adequate supplies of uranium.

Reactor Program Looks Good

Another optimistic argument: the AEC is currently contracting for the design of a natural-uranium fueled gas-cooled reactor with Kaiser Engineers. The significance is quite simple. While we consider enriched uranium to be the better fuel, some believe that to compete at this time in world markets U. S. manufacturers should be able to offer a natural uranium design. We are taking steps to have such a design.

The military reactor program is booming. As of Oct. 31, 1957, 5 reactors were operating, 20 were under construction and 14 more planned.

This is a spectacular growth rate, considering the first prototype is in operation for less than five years and the first nuclear-powered ship for only two years.

According to official statements, our Navy will be converted to nuclear power. You can watch this growth in the annual naval shipbuilding programs as they are presented to Congress.

The keel for the Navy's first nuclear powered surface ship was laid in Dec. 1957, well ahead of schedule. Their third A-sub, a production model, sailed on her trials in the fall of 1957, a full six months ahead of schedule and performed better than expectations.

Future Nuclear Power: Some Optimistic Arguments

Nuclear Power Utility Costs Will Drop

Electric power costs should come down with operating experience. Three times design output rating is feasible with the experimental boiling water reactor at Argonne, dropping operating costs from 52 to 32 mills/kwh.

Adequate Uranium Supply

The utility industry must be assured of healthy reserves of uranium before putting large investments into nuclear power plants. We now have a plentiful supply of uranium ore.

Fuel Fabricators and Reprocessors Are Available

Nuclear power calls for fabrication of uranium metal into fuel components, and for reprocessing of spent fuel elements from the reactor. This "service industry" is developing rapidly and efficiently.

Big Market Coming in Nuclear Propulsion

In addition to work for the Navy, the reactor experiment for the first nuclear powered merchant ship started up last Dec. Hull construction is now out on contract, and there is a promising market in propulsion.

A power reactor, developed for the Army, has been operating for eight months. As a step toward providing the Armed Forces with practical nuclear power in remote and relatively inaccessible areas, this project has more than met our expectations. That type of plant is expected to be one of a family of small plants which can provide heat and electricity for military installations, where the supplying of conventional fuels poses a difficult logistical problem. The Army also is keenly interested in small mobile power plants, the development of which is already underway.

Our purely civilian nuclear power development program is also coming along despite the higher than estimated costs currently experienced. Underway is an AEC program for building small experimental reactors to test new concepts.

In the 12 months of 1957 we have brought into operation a boiling-water reactor, a sodium-graphite reactor, and an organic-moderated reactor as part of our program.

The Shippingport pressurized-water reactor, a commercial-scale project, although still an experiment, achieved criticality recently.

In addition, the General Electric Co. brought into operation its own Vallecitos, Calif. boiling-water reactor. As Dr. Walter Zinn, one of the world's foremost reactor experts, put it recently, "Now we can begin to get results—we've put some money in the bank and we can begin to draw on it."

EBWR Costs Come Down

What did he mean? Several large reactor manufacturers are nearing the end of their tooling up to handle future orders.

But Dr. Zinn also might have had in mind experiments like the Argonne boiling-water reactor. It has operated the equivalent of full power for 100 days in the first 10 months of its operation. Operating cost has been high. Much too high. But when J. W. Harrer, project chief for the reactor, looked into the bank recently this is what he saw: If output were raised three times the initial design rating, which is considered feasible, operating costs would be reduced from an estimated 52 mills/kwh. to an estimated 32 mills.

Cost would still be too high to be economically competitive. But Harrer went on to say that if four identical reactors of this type (at the expanded output) were built in one multiple reactor station—with no extrapolation of design beyond what has already been learned—operating cost would come down to about 12 mills, partly because of lower fuel fabrication costs.

Twelve mill power from a 40,000 kwe.* power station is not econom-

* Kilowatts of electricity, in contrast to kilowatts of heat(kwhe). Efficiency of conversion from nuclear reactor heat to electricity is about 20-30%.

Future Nuclear Power: Some Pessimistic Arguments

Uranium Fuel Is Not Low in Cost

This is true. One gram of U-235 in enriched uranium costs from $9-$17; is equivalent to three tons of coal. Conventional electric power plants pay $4-$6/ton for coal or $12-$18 for an equivalent amount of energy.

Overly Optimistic Estimates For Nuclear Power

No one really knows which estimates are correct as to when nuclear power will become competitive in this country. A good guess would be around 1965. There is no doubt the early projections were way off.

Thermonuclear Fusion Will Obsolete Fission

Commercial thermonuclear fusion is a good 20 years away, so it is not a valid reason for pessimism. When it comes it will take its place as another competitor in the highly competitive electrical energy market.

Slow Progress in Nuclear Power

Actually progress has been anything but slow. Organized efforts to develop nuclear power is less than four years old. For a major technological revolution, progress has been very rapid.

ically competitive in the United States today. If Harrer's estimated cost can be shaved by 25-35% in actual practice, that is to 8-9 mills, we are in business in the world's largest power equipment market. Of course the last increment of cost reduction is generally the hardest to achieve. At least we have the target in sight even, if we are not quite within shooting range.

If a new plant of this type were started today, it would take about 30 months to put in operation, mostly because of time required to obtain generating equipment. The impact on uranium requirements, therefore, would not be significant in the early 1960's, unless several million kilowatts of such reactors were started in the next year or two.

Nuclear Propulsion Coming

Nuclear power for merchant ships, considered by many to be an easier economic target than central-station power, is also coming along. In addition to work now underway for the Navy on reactors to power surface vessels, the critical experiment for the first nuclear powered merchant ship started up last Dec. A contract for hull construction has already been let.

Why All the Pessimism?

Why the prevailing mood of pessimism? Without going into detail, it can be summed up in a very few words — disappointment progress has not been faster.

Many tend to forget the first atomic chain reaction took place only 15 years ago; the first Hanford reactor has been operating 12 years; extensive organized efforts to develop civilian power reactors have been going on for less than 4 years.

Industry could not participate in this program on its own initiative prior to the Atomic Energy Act of 1954, approximately 4 short years ago.

This mobilization period, considering that much laboratory development had to be accomplished and skills learned before the industry could go forward on a commercial basis, has been startingly rapid when compared with any other major technological advance. When one backs off and looks at the forest instead of examining individual trees, one perceives that industry and the Government have made remarkable strides in harnessing the atom.

Thermonuclear Fusion Threat

There is one more reason for some of the pessimism in the fission power field. This is the advance made in controlling thermonuclear fusion.

Those engaged in this effort have made great progress. But they are now approaching the position held by fission energy back in 1940-42. Assuming their efforts are successful in about the same length of time as it may take atomic power, the date would be about 20 years from now.

What impact will this have on the future of atomic energy as we know it? Fusion will have the problem of competing not only with coal, oil and gas as we now must, but it will also have to compete against the (by then) vastly improved fission reactors. That will be no easy task. Thermonuclear energy, when successful, will be but one more competitor for a share of an ever increasing, truly competitive energy market.

When Competitive Power?

Any discussion of the impact of nuclear power raises two basic questions. The first is "When will this impact occur?" The second is "What will be its effect when it does occur?"

When nuclear power plants will be with us in quantity has been the subject of a number of speeches and even of entire books. Naturally there is no unanimity of opinion in this field among the experts. Each new speech or publication brings forth a new statistical projection.

It is apparent that some early estimates concerning the timing and rate of growth of nuclear power have been overly optimistic. For instance the McKinney panel report contains a so-called optimistic estimate that by 1980 there might be a nuclear capacity of more than 135-million kwe. Other forecasts went beyond this to 200-million kwe. and more.

For comparison purposes, the total power capacity in this country today is estimated at about 135-million kwe. The optimistic projections assumed, of course, that nuclear power costs would become competitive at a level of 7-9 mills within a few years. They also assumed a continuing growth of energy demand along the lines of the past.

A recently published forecast of the atomic energy industry, for the next ten years, was conducted under the auspices of the Atomic Industrial Forum. This forecast estimates that there will be no significant increase in the rate of power reactor construction in this country until the mid 1960's. The study

makes no firm projections for the period beyond that.

Economic Power in 1965

Which of these projections is correct? The fact of the matter is we do not know. Nuclear power reactors will be built in this country on a large scale only after the cost actually or prospectively is economically competitive over the life of the plant. The exact time when this will happen is still shrouded in imponderables.

At present a sound generalization, based on a composite of predictions, might be that nuclear-electric power will not be economically competitive in this country before 1965. Therefore, we should not expect any large scale construction before. This period, from now until the mid 1960's, will be a somewhat difficult one for a number of companies in the nuclear electric power field.

That doesn't mean, and must not mean, no new power reactors will be built in this country until then. Whatever the size of the research and development effort in this field, construction of small and large power reactors to test out new concepts and to improve existing concepts is absolutely a necessity.

There will also be construction of research and test reactors, reactors built for export, reactors built for military propulsion purposes, and perhaps fuel elements manufactured for export. Impact of all of this, however, will be relatively small in terms of uranium requirements during the next few years, if the composite forecast is correct.

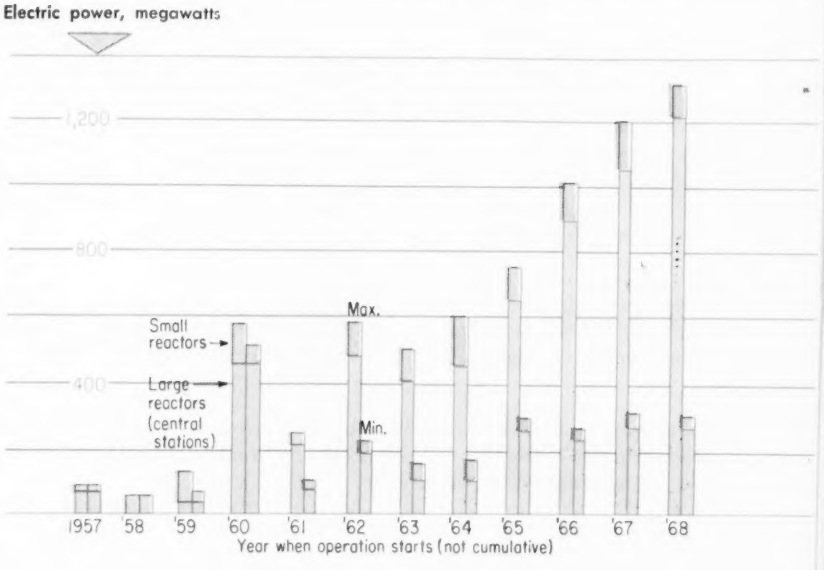
The Forum study, for instance, estimates that the total uranium requirements for U. S. reactors, including naval reactors, through 1965 may amount to no more than about 1,500 tons of U_3O_8 concentrate and as a maximum may not be more than 3,000 to 4,500 tons during that period.

Big Nuclear Market Coming

While it is difficult to project when economic nuclear power will arrive in this country, it is simpler to predict what may happen when it does come. The effect will be very considerable, to say the least, for the entire atomic energy industry.

Total installed generating capacity is at present about 135 million kwe. Over the past 50 years capacity has roughly doubled every ten years. While this same rate of growth might not be maintained in the future, even a greatly reduced rate would still constitute a tremendous expansion program.

Markets Abound for Small and Large Reactors in 1965



Fuel costs of our power industry are among the world's lowest, thanks mainly to our rich reserves of oil, gas and bituminous coal. But in spite of the general low level of fuel costs throughout the country, there are considerable differences in costs between various regions.

Fuel costs range from 10¢ per million Btu. in the gas fields of Texas to 35-40¢ or more in the Northeast, Florida and the Northwest, where it can be assumed a growing proportion of power capacity will not be based on water power.

Given a 35-40¢ fuel cost, it is possible for conventional plants to produce power at a total cost of 7-9 mills. When nuclear power costs reach this threshold level (or it becomes clear that such or lower costs can be achieved within a reasonable period of time after the reactor is constructed), utilities in the entire high-cost fuel area will find it economic to add nuclear instead of conventional plants.

What would this expansion amount to? Let's assume that the threshold is reached in the early 1970's.

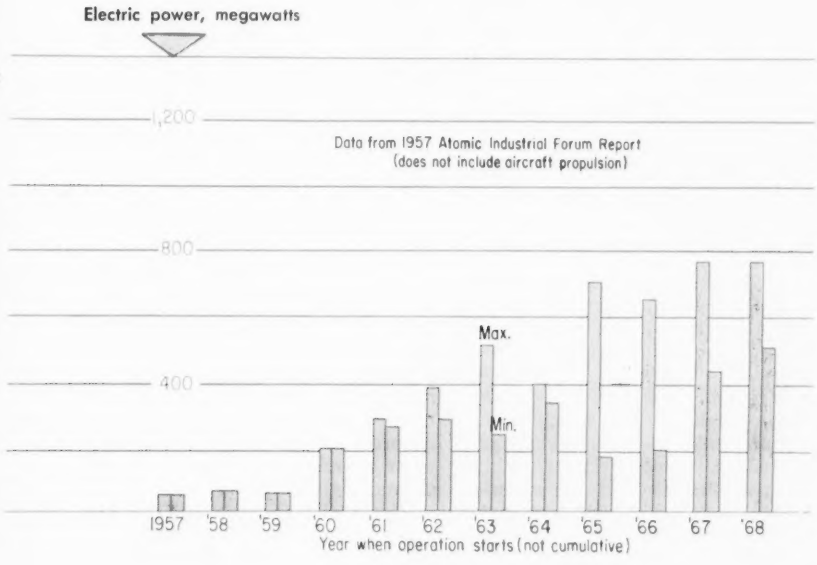
The high-cost fuel areas include about one-fourth of our generating capacity and should account for about the same percentage of the power expansion program. A continuation of the present nation-wide growth rate indicates that in the early 1970's about 20,000,000 kwe. of capacity would be added each year. To be conservative let us assume that only 16,000,000 will be added. One-fourth of that would be 4,000,000 kwe. in the high-cost fuel areas. This would be the nuclear power sales target.

But a secondary effect is expected to play a part. Once costs can be reduced to the 7-9 mill range by technical improvements and some increase in production volume, these same factors will contribute to even lower costs later on. When the threshold is crossed and nuclear power plant sales break into the big time, the market area should enlarge rapidly because of even lower costs; attributable to the additional factors of mass production of fuel elements and high throughputs in chemical processing plants.

Future Uranium Demands

All this has special meaning in terms of uranium requirements.

Healthy Business in Military and Maritime Reactors by 1965



Market for Nuclear Systems*

	Gross Millions of $ Per Year Spent			
	1960	1961	1964	1968
Large reactor stations				
Max.	115	45	95	175
Min.	105	20	25	45
Small reactors				
Max.	70	30	100	65
Min.	40	25	40	20
Military, maritime				
Max.	140	205	270	425
Min.	140	185	235	295

* Includes U. S. built small foreign reactors but only domestic large reactors. Excludes aircraft propulsion. Small reactors include power reactor prototypes, test reactors, process heat units.

One general characteristic of power reactors is initial requirement for uranium is far greater than the annual requirements thereafter.

In terms of concentrate, initial fuel inventory required for each 1,000,000 kwe. of power reactor capacity can be roughly estimated at about 1,500 tons, which includes about 500 tons necessary to fill the supply "pipeline."

Again in terms of concentrate, the annual burn-up and loss of fuel for each million kwe. can be roughly estimated at about 300 tons.

One quick example will suffice to illustrate the figures. Let us assume a year in which existing nuclear power capacity amounts to 10 million kwe. and a total of 3 million kwe. of new capacity is added. Total requirements in terms of concentrate would be about 7,500 tons in that year—some 3,000 tons to keep existing plants running and about 4,500 tons for the initial needs of the new plants. Assuming the same addition of new plants the following year, the total requirements in that year would be about 8,400 tons.

Let's Look at Our Assumptions

In arriving at these general uranium requirements per million kwe. certain assumptions were used, which at this time appear to be quite reasonable.

First, the reactors will use enriched uranium as a solid fuel. About one-third of the U-235 content of the original concentrate is "lost" in processing, either in the diffusion plants or elsewhere in the processing chain.

Second, reactors will be in the thermal, or slow, neutron range and have on the average a specific power of 1,000 kwhe. per kg. of U-235. The latter figure indicates the amount of fuel inventory required for a certain power level and is a quite arbitrary assumption. There are reactor designs that will require considerably more or less fuel inventory per power output.

Third, about 20% of the power produced in these reactors will come from plutonium formed in the reactors. They will be operated at about an 85% load factor during this period.

While reactors might be built around the thorium-U-233 cycle, or with plutonium fuel elements, it appears that during the next few years most of the power reactors will be thermal, uranium-fueled reactors. Most of the research has been on these types.

The next question that comes to mind is whether the civilian requirement will be part of the present and projected AEC requirement for concentrate or whether it will be in addition to it.

While we at AEC have considered this, we have no answer at present, mainly because the problem is still in the future. At present, civilian and export requirements for enriched uranium are included in the overall purchases made by the AEC and are allocated by the President for civilian purposes.

Thus far the President has allocated 100,000 kg. of U-235, with half scheduled for domestic requirements and half for export. However, the allocation covers requirements of domestic projects for the entire useful life of the plants—far above the actual current delivery requirements.

The question is, of course, "When will civilian requirements added to military requirements begin to raise the level of the planned AEC purchasing program?" There is no factual answer today.

The AEC procurement program will include all concentrate required to produce enriched uranium because AEC is the sole domestic source for this material. However, the law permits private trade in natural uranium. There would be no reason for AEC purchases to include requirements for reactors fueled with natural uranium, provided private facilities are available for the conversion of concentrates into metal or oxide.

Military requirements, which form such a large share of demands today, depend largely on world conditions far into the future. It would not be meaningful to estimate these needs—so much can happen in the next 10-15 years.

This factor, together with the indefiniteness of when nuclear-electric power will cross the cost threshold, add up to the fact that no projections for uranium requirements can be relied upon with certainty.

However, when the cost threshold is reached, the resulting growth in nuclear-electric power capacity, and the resultant requirement for uranium, will be so rapid even diminishing military requirements should hardly be noticed by the mining and milling industry.

Growing Overseas Markets

It should be remembered that many industrialized foreign nations are also engaged in putting the atom to work.

Some of these countries, particularly in Western Europe, will have to import uranium to fuel their reactors. At least a portion of that future market is available to U. S. producers.

The Euratom† countries have an initial goal of 15,000,000 kwe. of nuclear-electric capacity by 1967. To achieve it, they will need a minimum of 35,000 tons of uranium concentrate. Others, making possibly more precise projections and taking into account the specific type of reactors considered by Euratom, place the requirement as high as 70,000 tons. Magnitude of these numbers is of critical importance as a sales target. These numbers are averages suitable for general planning. They probably are an inadequate basis for analyzing a specific market such as Euratom.

† Belgium, Luxembourg, Netherlands, Italy, France, Germany.

U-235 Not Cheaper than Coal

While the future looks potentially bright for the industry, there is a factor which should be kept in mind. Contrary to some popular notions, the cost of uranium in terms of energy is not necessarily lower than that of coal or oil.

One gram of U-235 is roughly equivalent in energy value to three tons of coal. Cost of one gram of U-235 in enriched uranium varies from about $9 in low enriched to $17 in highly enriched uranium as UF_6. In comparison there are quite a number of conventional power plants that pay no more than $4-6 for a ton of coal or $12-18 for an equivalent amount of energy. These prices are not an argument necessarily for lower uranium prices; rather they emphasize the point that to make nuclear power economic, costs all along the line must be kept low.

There is also the fact that coal can be used with very little, if any, additional processing, while uranium ore requires many chemical and metallurgical operations after it leaves the mine.

Costs Must Be Reduced

The uranium industry, during this transition from a military to a civilian market, should give considerable thought as to how it can help make uranium a competitive fuel. If total fuel cycle costs, from the mine to the waste tanks, can be reduced to competitive levels (which may well be lower than the cost of coal in many areas), I believe we can rely on the competitive nature of reactor manufacturers to bring capital costs into line.

Now let's summarize the key points. Demand for concentrate is about 1,500 tons per million kwe. as the initial requirement and about 300 tons per year thereafter to keep those plants operating.

Rate of domestic reactor construction is based on the naval shipbuilding program, which you can watch through presentations to Congress.

For nuclear-electric power and also marine propulsion, growth is based on the rapidity with which they become economically competitive. In this connection, look for lower capital costs, which can be achieved by simplification or by new designs or by increasing the power output beyond expectations, as in the Argonne case.

In the fuel cycle look for reduction in fabricating and processing costs. These may be accomplished by design changes, by greatly improved burnups and higher production volumes.

Watch several factors which will influence the quantity of uranium required per million kwe. These include development of higher specific power ratios (meaning lower inventories), an increase in the percentage of total heat coming from plutonium formed in the reactor, increased use of plutonium as an enriching agent, use of plutonium as fuel, and use of the thorium-U-233 cycle.

Based on a talk presented at a symposium on the future markets for uranium, co-sponsored by U. S. Chamber of Commerce and Uranium Institute of America, at Denver, Colo.

Looking Ahead: Central Station Nuclear Power Costs

Capital Investment (AIF 1957 Rpt.)

$ per net kilowatts of electricity

1957* (60 MWE)	1957* (90 MWE)	1960 (Est.)	1968 (Est.)
$1,070	$710	$380–480	$280–370

* Based on Shippingport operation. Costs include reactor equipment, structure, turbo-generator plant, indirect costs.

Initial Nuclear Fuel Costs in 1960 (AIF 1957 Rpt.)*

Mills per kilowatt of heat

	Max.	Min.	Min.†
Conversion to UO_2	0.8	0.4	0.4
Fabrication to metal parts	3.6	2.4	2.2
Inventory charges (4% of value)	1.3	0.7	0.7
Burnup with Pu credit	1.3	1.1	0.7
Radioactive processing and preparation for recycle, including transportation	1.1	0.8	0.8
Losses	0.3	0.2	0.2
	8.4	5.6	3.6

* Large water type reactors in U. S. using slightly enriched UO_2.
† Alternate minimum based on $30/gm. Pu buy-back. Other costs based on $12/gm.

Vertical Pumps . . .

. . . Finding Many New Process Applications

- Many important improvements in design
- A host of new bearing materials are now available
- Self-priming
- Safe operation is provided
- Self-draining
- Stuffing box leakage is eliminated
- Submerged operation is possible

JAMES P. CANNON, Lawrence Pump & Engine Co., Lawrence, Mass.
J. A. LUNDQUIST, Registered Professional Engineer, Philadelphia, Pa.*

NOT TOO many years ago, a process engineer confronted with the question, "Vertical pumps—where?" might very aptly have answered, "Why nowhere."

Today, with many new requirements for pumps in the process industries, engineers have turned their eyes back for a second glance at the vertical volute pump. This reconsideration has brought about a host of improvements in the design of vertical pumps.

While there are many advantages to be had from the use of vertical pumps, always keep in mind their place in relation to horizontals. We aren't saying that all horizontals should be replaced. In fact, a horizontal pump is a better selection if it meets all the requirements of service and maintenance. We're getting at those cases where the horizontal pump isn't reliable and is a maintenance headache.

What Are the Complaints?

Complaints frequently heard about vertical volute pumps are standard. That there is some substance to these complaints is true. We'll just try to put them in their proper perspective.

*Meet your authors on pp. 182, 179.

The major points against these pumps are:

- Pumps of this type are designed for intermittent service with water and won't stand up on a heavy production job.
- Available bearing materials are limited, giving a bad corrosion and contamination problem.
- Maintenance costs on vertical pumps are too high.
- First cost of a vertical pump is far greater than a comparable horizontal pump.

Originally, the vertical volute centrifugal pump was designed for drainage service and for many years this was the only work so-called "sump-pumps" were expected to do. Today, in terms of numbers, more vertical volute pumps are still sold for this service than for any other purpose.

Peculiarities of this type of job left its mark on the pump. Manufacturers designed it for intermittent use; efficiency was compromised for large clearances since nonclogging characteristics were wanted; and head characteristics were low when compared with most centrifugals since sump applications require little head.

Large portions of drainage pump sales go through building contractors where price competition is keen. Manufacturers, therefore, trim their designs to the bare essentials required by their jobs.

Since there's very little comparison between intermittent water sump service and continuous duty in, say, an acid tank, it's not too surprising that those who first tried to make use of vertical volute pumps in process operations lost out. Today, the story is a little different—the chemical engineer can have a vertical volute pump that's been designed for his specific job.

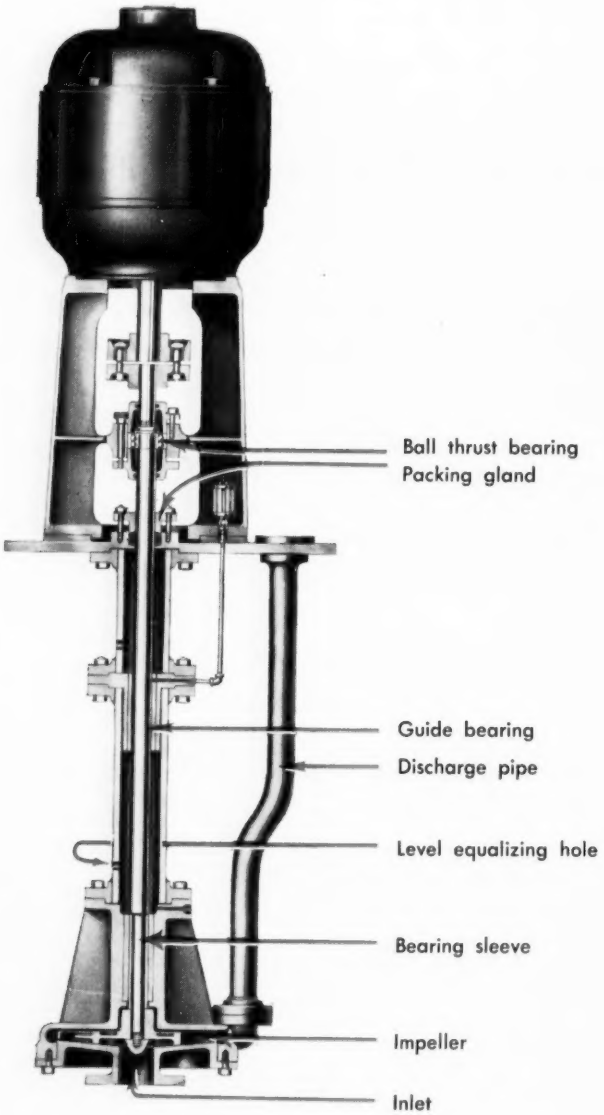
Now, Here Are the Advantages

Safety—Today, in most plants, safety programs are of the utmost importance. This is especially so in the chemical industry.

To all safety engineers, no matter where, one great source of worry has always been the storage tank that contains a dangerous chemical and has a bottom outlet. Not only does the bottom outlet offer an ideal spot for corrosion to start but the nozzles and pipes leading to it are in danger of being hit and broken. A broken nozzle from such an accident could be disastrous.

Air is sometimes used to discharge these tanks in preference to

Here's a Cross-Sectional View of Vertical Pump



a bottom outlet. This system, too, has its disadvantages; uncontrolled flow being the big danger. In case a break occurs between the tank and the control valve, or even a leak in the control valve itself—it would be impossible to stem the leak until the tank pressure equalized. With some chemicals, this could cause a great deal of damage.

In contrast, pump controls can be placed in a safe and convenient location to always give the operator instant control.

Another point to make here is, while many chemicals are quite safe to handle as liquids, they become highly flammable when mixed with air. It's true, an inert gas can be used, but this is generally too expensive. It appears, the safest way to remove a dangerous chemical from a tank is by pumping it out of the top with a vertical pump.

It's sufficient to say that in almost all cases where dangerous chemicals are stored in tanks, vertical submerged pumps will have the blessing of the safety department.

Stuffing Box Leakage—The safest way to avoid stuffing box leakage is simply: don't let the product reach the box. This is how a vertical pump operates. Holes bored in the supporting pipe keep the liquid level in the support pipe the same as in the tank; well below the stuffing box.

Packing or mechanical seals protect against vapor leaks, but the big point is that the seal of a vertical volute pump never comes in contact with the liquid.

Submergence — When handling liquids close to their boiling point, the vertical pump has the advantage of being self-venting. Cavitation will still occur if there's insufficient submergence, but it won't trap gas as a horizontal pump does and it will not become gas-bound. This doesn't mean that a vertical pump should be operated continually with an insufficient net positive suction head since the vibration generated can be damaging.

Self-Priming—When it's necessary to operate with a suction lift, as when a tank is buried, no other pump is as positive as a vertical submerged pump. Regardless of the methods used to prime another type of centrifugal pump, there's always the problem of leaky and constricted suction lines and leaky stuffing boxes. Both of these can cause valuable loss of production without warning.

Self-Draining — In many batch operations, it's necessary to drain the sytem at the end of the batch. In the case of horizontals, the pump must be especially drained. With the vertical pump, either submerged in a tank or mounted on the outside, the pump is drained automatically with the system.

Bearings Are Important

Originally, vertical pumps were run at very low speeds so that bearings made of wood or iron were sufficient. As pump speeds increased, wood bearings became useless. Today, bronze and cast iron are the most common bearing materials. Both of these have definite limitations as far as corrosion is concerned. Stainless steel makes an

excellent bearing, but, since the shaft is usually made of stainless, there's an ever-present danger of galling (scoring and wearing away of the surfaces by abrasive materials).

One of the most important single advances made in adapting vertical pumps for process service came with the development of a glass-filled Teflon radial bearing.

Many other materials have useful but limited bearing applications. Carbon is particularly good when it's impossible to lubricate the intermediate bearings. Carbon in combination with various metals, known as Carbolube, is also useful when bearings have to be run dry. Metals used here include cadmium, babbitt, copper and silver.

In one case where a pump was operating in hot tar, Carbolube bearings of bronze and carbon were installed. With operation of the pump averaging 6 hr./day, the bearings have stood up successfully for the last three years.

In another case, the pumping of a material like titanium tetrachloride is tough on the bearings. Stellite sleeves running in combination with heat-treated Meehanite or alundum bearings were found to be an ideal combination here.

Many Uses Can Be Found

Many chemical processes have found the need for vertical volute pumps. When installed these pumps have operated successfully. Some examples of their use in the chemical industry are illustrated below and in the accompanying photographs.

Elimination of Tankcar Unloading Station—One manufacturer in intraplant deliveries of sulfuric acid, makes use of a railway tankcar. Unloading stations at the various units the acid was delivered to gave operating and maintenance problems. Vertical pumps were installed in each of the tankcars so the unloading station could be completely done away with.

This company had experience with vertical submerged pumps in acid storage tanks. They ran the pumps frequently enough not to have to worry about freezing-up. However, in the tankcar application, the cars are left on a siding for as long as a week after discharging their cargo of acid. Moisture in the tanks add to the corrosion problem and the radial bearings would freeze up in days.

Many materials were tried for the bearing and shaft on the vertical pumps. Most successful found, turned out to be a combination of a Carpenter-20 shaft with a glass-filled Teflon bearing. This bearing is manufactured by the Chemical and Power Products Co.

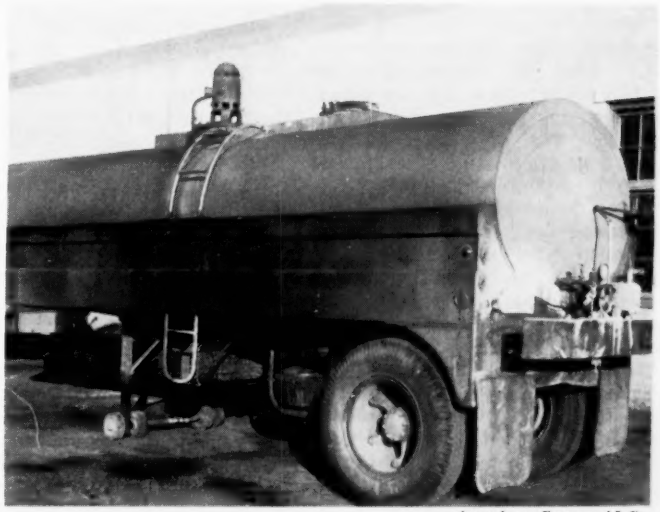
Ten of these tankcars are presently in use. One of the cars is shown in the accompanying photograph. By looking closely, you'll see that vertical clearance isn't sufficient for interplant transport. These cars are therefore confined to a single plant site.

All the pumps involved in this type of work have their intermedi-

Eliminates Tankcar Unloading Station

American Cyanamid Co.

Avoids Tanktruck Bottom Outlet



American Cyanamid Co.

ate bearings exposed to a combination of acid and moisture whenever the cars are at a siding. Yet, none of these pumps have frozen in the four years they've been in operation.

Since this initial trial in the tankcars, the combination of a Carpenter-20 shaft with the glass-filled Teflon bearing has been installed in a number of tough jobs and has always performed satisfactorily. Good corrosion resisting properties of both materials plus the "slipperiness" of the glass-filled Teflon makes them an ideal combination.

Avoid Bottom Outlet — Another important use for the vertical volute pump has been the elimination of the bottom outlet on a tank truck. The photograph of the truck shows the placement of this pump.

Be Careful in Selection

In a plant where only one or two vertical volute pumps are operating, costs may be high and the first conclusion is that vertical pumps cost more to maintain than horizontals.

Too often, this judgment is pronounced with little thought. Most vertical pump troubles are really the result of misapplication or faulty maintenance. When you handle any pump that way you're in for trouble. It's just that verticals aren't as common as other pumps and men unfamiliar with this equipment are more likely to make mistakes.

As an example, a vertical pump installation on tanks containing volatile liquids. Here, it's much more difficult to detect an insufficient NPSH (net postive suction head) than on a horizontal pump because the pump is submerged and noises due to cavitation are dampened. More important, mistakes can be made in selection. Too light a pump or use of the wrong materials of construction will most certainly result in trouble.

Mistakes in application can generally be minimized by making use of a specialist from a company that manufactures vertical volute pumps for the chemical process industry.

Preventive Maintenance Fits In

Maintenance problems are not quite so easy to solve. If your maintenance men haven't had too much experience with vertical pumps, a few suggestions may be helpful.

"Pulling" the Pump — In your original installation, make sure you give some consideration as to how you can "pull" the pump. Pay attention to overhead clearance, convenient beams to rig a sling on and areas a portable crane can travel through to reach the site.

It isn't always possible to locate the pump in an ideal position, but, a little thought before installation will usually result in a better-than-average location. Pumps that are hard to "pull" will be neglected.

Periodic Checks—Run regularly scheduled periodic checks on your vertical pumps. Preventive maintenance of this type is particularly important with submerged pumps since they're out of sight and this, in many cases means, out of mind. You'll be able to determine from experience on any particular job whether these checks should be made every six months, every year or even every two years.

Most equipment has that one critical part that's the limiting factor to uninterrupted operation. With the vertical submerged pump, it's the wearing surface of the submerged shaft and bearing. You should know what the original clearance is for a particular pump and consider a 100% increase as the point for bearing renewal. Failure to detect this wear can result in a complete pump breakdown.

Worn bearings cause excessive vibration that, when put together with corrosive conditions, can bring about loosening of nuts and bolts with a consequent dropping of the impeller. Vibration will eventually cause the ball thrust bearing at the top of the pump to fail. Result—the shaft dropping and the impeller running against the suction cover.

Either of the above situations calls for a large number of spare parts and extensive overhaul. Regular preventive maintenance would have held the repair to two bearing surfaces.

Alignment—Complaints are often heard that bearings wear elliptically in submerged pumps. Wear of this type is nearly always a sign of pipe strain. Because there's only one connection to the vertical and the pump end is out of sight, many maintenance men fail to recognize strain on the discharge pipe as being damaging.

Radial bearings must line up with the ball thrust bearing and motor. Any strain on the discharge pipe can throw the bottom bearing out of line and uneven wear will result.

By making use of the following suggestions and with reasonable care, the problem of uneven wear can be beaten.

- Securely fasten the discharge pipe to the sump cover.
- Sump covers must be heavy enough not to flex.
- Sump covers must be shimmed before bolting down.
- Install flexible connections above the sump cover.

If a pump is correctly selected and installed, maintenance will be at a minimum. One company that uses a large number of vertical pumps, gives every pump in their plant that's on continuous duty, a yearly overhaul. This includes both horizontal and vertical pumps.

Their records show that vertical pumps require approximately twice as much time for overhaul as do the horizontals. Cost of replacement parts is similar.

While this indicates that the vertical pump requires more work, remember, this is a once-a-year process. Also, the big point is that this same company, didn't have any lost time due to a vertical pump not operating.

Initial Cost Is High

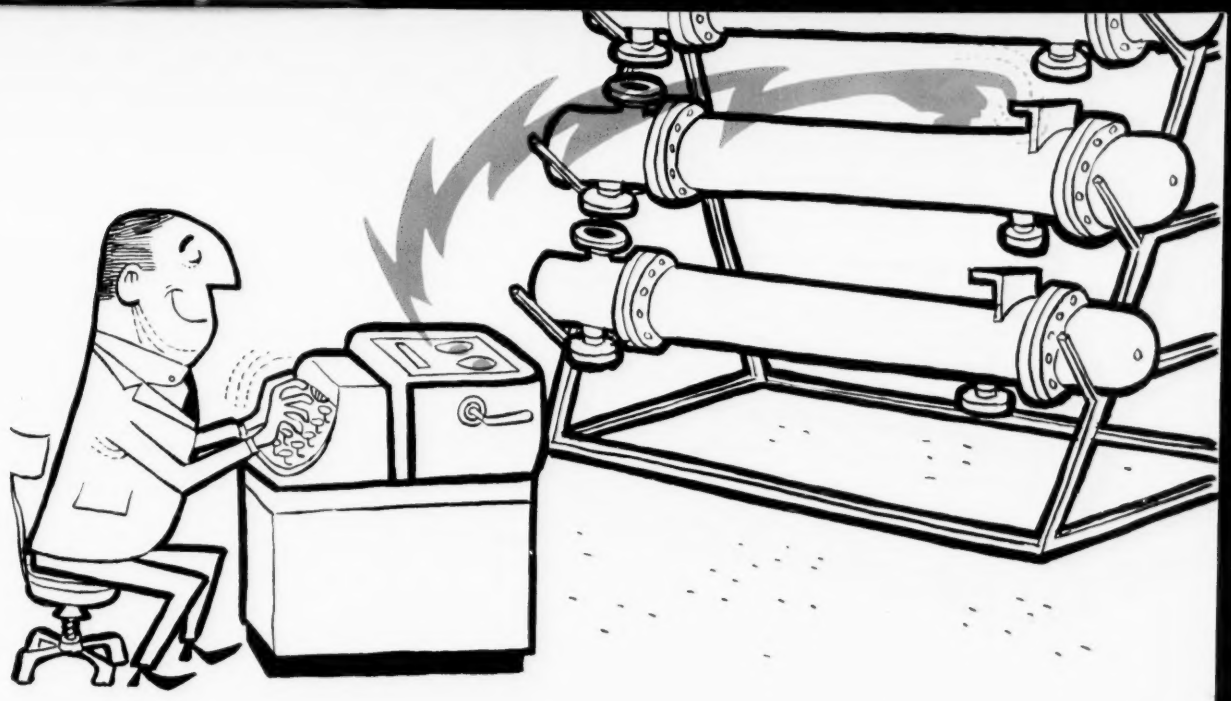
Now to the question of first cost. Here's the strongest point against the vertical volute pump. Verticals definitely cost more than horizontals.

It's impractical to present an example that'll illustrate this point of cost since the particular conditions of each job have a great effect on the final price. Any example selected would be misleading.

However, there are some rules-of-thumb that give a fast idea of how costs compare:

- A short vertical pump, about 5-ft. long, in all iron construction or bronze fitted, won't cost much more than a standard horizontal suction pump. It will probably cost less than a cast iron self-priming pump.
- In stainless, the vertical is going to be much more expensive than a standard pump. It will also, but by a smaller margin, be more expensive than a self-primer.

You must check the cost of the vertical for each individual job to know whether its advantages outweigh the increase in price.



Let Computers Pick Your Exchangers

Automatic computers relieve engineers of tedious calculations, give optimum designs of heat exchangers quickly, and save money.

R. E. GITHENS, JR., Engineering Department, E. I. du Pont de Nemours & Co., Wilmington, Del.*

Heat exchanger calculations are quite often repeated using the same equations and procedure, with only the numbers themselves being different. The complex arithmetic of the operations makes them time-consuming and tedious. At DuPont, about 50% of all heat exchanger ratings are done on a digital computer, and eventually over 80% will be programmed for machine computation.

The extremely rapid calculation time, the inherent computer accuracy and the ease of problem solution are distinct advantages of computers in rating heat exchangers. Potential investment savings due to optimum exchanger design add to the benefits of this method.

Each year, thousands of heat exchangers, representing an investment of over 50 million dollars, are purchased by the chemical industry. Since cost reduction of a few percent amounts to a valuable saving, it is worthwhile to rate exchangers properly. Also, for every heat exchanger that is ultimately bought, at least three units probably have been rated, on the average. This represents a large work load which for economic reasons should be performed at the lowest possible cost.

Exchangers are removed sometimes from their original service and, in order to use them elsewhere, it is necessary to know what can be expected of them under new operating conditions. For instance, exchangers which were designed as condensers may be used later as reboilers, or units originally designed to handle gases may be changed to liquid service. New conditions of flow, temperature and pressure often result in a different performance by the unit. An engineer frequently must examine many existing "out-of-service" exchangers to choose one suited for a new process application.

It is both possible and profitable to formulate a generalized solution, based on empirical equations and proper fouling allowances, to the problem of designing or selecting a given type heat exchanger. The only variables handled are the specific physical properties for the particular problem at hand. This type calculation is well suited to machine solution.

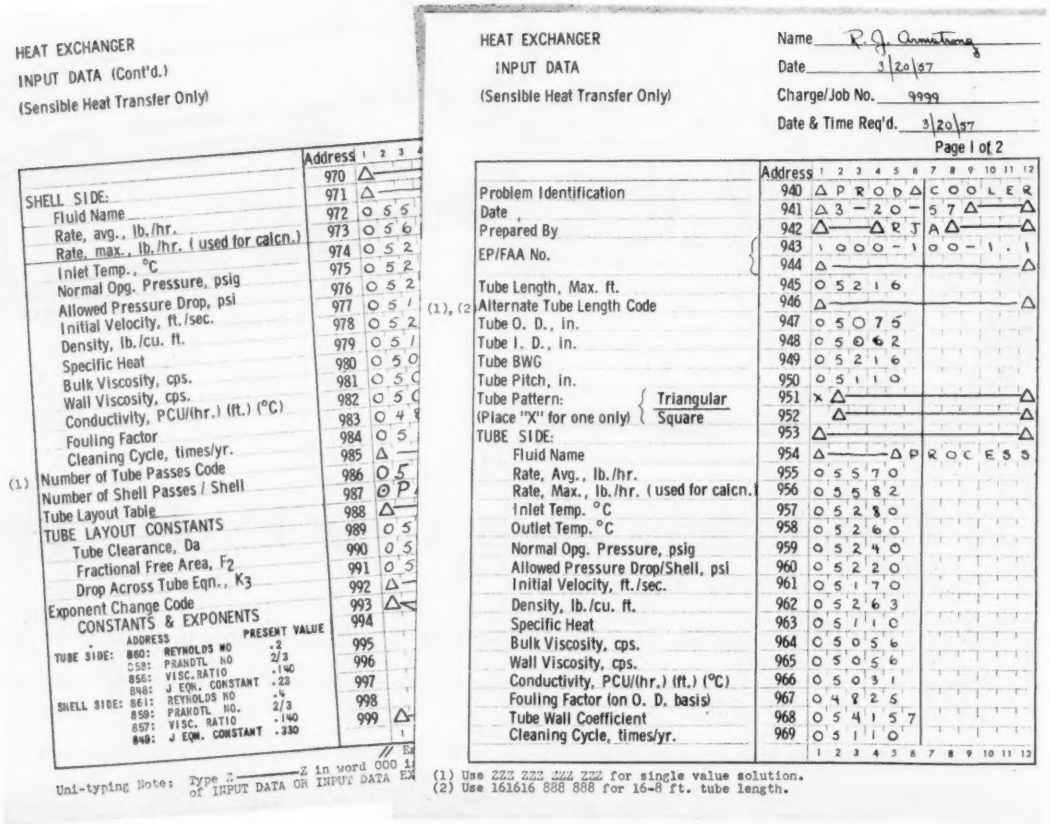
Look at the Tools

There are two main classes of computing equipment. The first is the analog computer, which simulates electrically the equations used. This computer is very fast and can be used to explore a wide range of variables in a matter of minutes. The results are plotted as curves on automatic chart recorders. Actual design information must be read from these curves and written into equipment specifications by the engineer.

The second type machine is the digital computer, which essentially does arithmetic at extremely high speeds. Since arithmetic consists of performing operations with numbers, or digits, the digital computer results are themselves numbers and are printed directly by the machine.

* Meet your author on page 179.

Engineer Fills in the Blanks . . .



HEAT EXCHANGER
INPUT DATA (Cont'd.)
(Sensible Heat Transfer Only)

	Address
SHELL SIDE:	970
Fluid Name	971
Rate, avg., lb./hr.	972
Rate, max., lb./hr. (used for calcn.)	973
Inlet Temp., °C	974
Normal Opg. Pressure, psig	975
Allowed Pressure Drop, psi	976
Initial Velocity, ft./sec.	977
Density, lb./cu. ft.	978
Specific Heat	979
Bulk Viscosity, cps.	980
Wall Viscosity, cps.	981
Conductivity, PCU/(hr.) (ft.) (°C)	982
Fouling Factor	983
Cleaning Cycle, times/yr.	984
(1) Number of Tube Passes Code	985
Number of Shell Passes / Shell	986
Tube Layout Table	987
TUBE LAYOUT CONSTANTS	988
Tube Clearance, Da	989
Fractional Free Area, F_2	990
Drop Across Tube Eqn., K_3	991
Exponent Change Code	992
CONSTANTS & EXPONENTS	993
ADDRESS — PRESENT VALUE	994
TUBE SIDE: 860: REYNOLDS NO .2	995
858: PRANDTL NO 2/3	996
856: VISC.RATIO .140	997
SHELL SIDE: 861: REYNOLDS NO .4	998
859: PRANDTL NO. 2/3	999
857: VISC. RATIO .140	
849: J EQN. CONSTANT .330	

Uni-typing Note: Type ; ——— Z in word 000 1
of INPUT DATA OR INPUT DATA

HEAT EXCHANGER
INPUT DATA
(Sensible Heat Transfer Only)

Name R. J. Armstrong
Date 3/20/57
Charge/Job No. 9999
Date & Time Req'd. 3/20/57
Page 1 of 2

	Address	1 2 3 4 5 6 7 8 9 10 11 12
Problem Identification	940	Δ P R O D Δ C O O L E R
Date	941	Δ 3 — 2 0 — 5 7 Δ
Prepared By	942	Δ Δ R J A Δ
EP/FAA No.	943	1 0 0 0 — 1 0 0 — 1 . 1
	944	Δ
Tube Length, Max. ft.	945	0 5 2 1 6
(1), (2) Alternate Tube Length Code	946	Δ
Tube O. D., in.	947	0 5 0 7 5
Tube I. D., in.	948	0 5 0 6 2
Tube BWG	949	0 5 2 1 6
Tube Pitch, in.	950	0 5 1 1 0
Tube Pattern: Triangular	951	X Δ
(Place "X" for one only) Square	952	Δ
TUBE SIDE:	953	Δ
Fluid Name	954	Δ Δ P R O C E S S
Rate, Avg., lb./hr.	955	0 5 5 7 0
Rate, Max., lb./hr. (used for calcn.)	956	0 5 5 8 2
Inlet Temp. °C	957	0 5 2 8 0
Outlet Temp. °C	958	0 5 2 6 0
Normal Opg. Pressure, psig	959	0 5 2 4 0
Allowed Pressure Drop/Shell, psi	960	0 5 2 2 0
Initial Velocity, ft./sec.	961	0 5 1 7 0
Density, lb./cu. ft.	962	0 5 2 6 3
Specific Heat	963	0 5 1 1 0
Bulk Viscosity, cps.	964	0 5 0 5 6
Wall Viscosity, cps.	965	0 5 0 5 6
Conductivity, PCU/(hr.) (ft.) (°C)	966	0 5 0 3 1
Fouling Factor (on O. D. basis)	967	0 4 8 2 5
Tube Wall Coefficient	968	0 5 4 1 5 7
Cleaning Cycle, times/yr.	969	0 5 1 1 0

(1) Use ZZZ ZZZ ZZZ ZZZ for single value solution.
(2) Use 161616 888 888 for 16-8 ft. tube length.

Fig. 1

Several equipment manufacturers have developed their own programs for heat exchanger rating by card programmed calculators. We have available for engineering use a Remington Rand Univac I—a magnetic tape programmed digital computer. Machine instructions are prepared by typing magnetic pulses onto tape. These instructions consist of the general program, which is permanently stored on magnetic tapes, and of specific information relating to the problem being solved.

The magnetic pulses on the tapes are interpreted by the electronic portion of the computer. Calculated results, both intermediate and final values, are stored on tape by the computer. Finally, these results as well as input data can be translated by an electronic typewriter which prints them onto a prepared form.

Easy Does It

Fig. 1 shows input data forms for rating heat exchangers on Univac. The rating engineer fills out this form with the physical properties of the fluids involved, the limitations placed on pressure drop and the thermal requirements of the exchanger.

The numbers are written in the "excess 50" floating decimal system. The number 1, for example, is written 0511000. The first digit is the sign position—0 shows the number is positive and — denotes it is negative. All numbers to be coded are written $0.XXX \times 10^n$ so that the decimal point precedes the first significant figure. The exponent n is added algebraically to 50, and this sum is written in the second and third position. Beginning at the fourth position, the significant numbers are written.

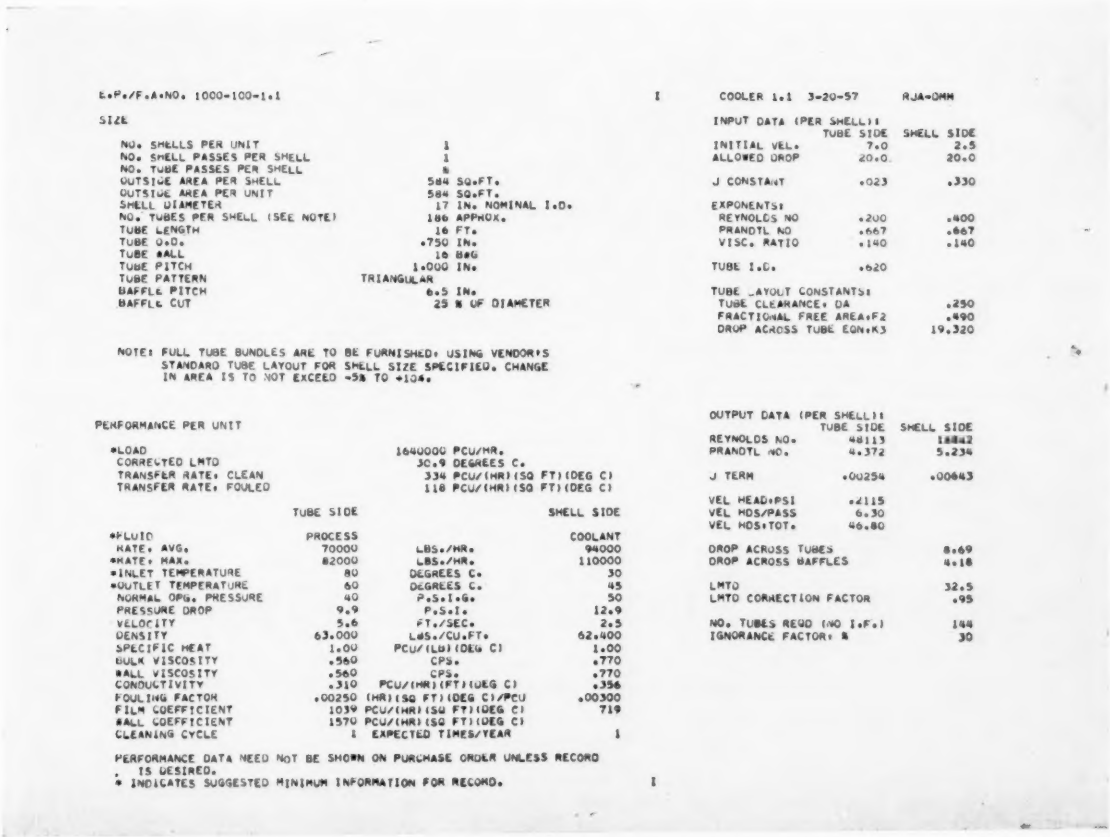
Thus, Address 962 of the input sheet—05263—means 0 52 63. The 0 indicates the number is positive; 52 is $50 + n$, or $n = 2$; 63 is 0.63. Therefore, the number is 0.63×10^2 or 63.

The symbol Δ on the form is a printer space.

When the input has been stored on magnetic tape, it is mounted in the proper place on the computer. Other tapes that are mounted at this time are the program tape, containing all the instructions for the solution of the problem; a tube layout table tape, which is searched for the proper shell and number of tubes; and blank tapes for use during computation and for recording output data.

The operator starts the machine after the tapes are mounted, and the computer begins calculations.

. . . Computer Prints Out Exchanger Specifications



E.P./F.A.NO. 1000-100-1.1

SIZE

NO. SHELLS PER UNIT	1	
NO. SHELL PASSES PER SHELL	1	
NO. TUBE PASSES PER SHELL	4	
OUTSIDE AREA PER SHELL	584	SQ.FT.
OUTSIDE AREA PER UNIT	584	SQ.FT.
SHELL DIAMETER	17	IN. NOMINAL I.D.
NO. TUBES PER SHELL (SEE NOTE)	186	APPROX.
TUBE LENGTH	16	FT.
TUBE O.D.	.750	IN.
TUBE #ALL	16	BWG
TUBE PITCH	1.000	IN.
TUBE PATTERN	TRIANGULAR	
BAFFLE PITCH	6.5	IN.
BAFFLE CUT	25	% OF DIAMETER

NOTE: FULL TUBE BUNDLES ARE TO BE FURNISHED, USING VENDOR'S STANDARD TUBE LAYOUT FOR SHELL SIZE SPECIFIED. CHANGE IN AREA IS TO NOT EXCEED -5% TO +10%.

PERFORMANCE PER UNIT

*LOAD	1640000	PCU/HR.	
CORRECTED LMTD	30.9	DEGREES C.	
TRANSFER RATE, CLEAN	334	PCU/(HR)(SQ FT)(DEG C)	
TRANSFER RATE, FOULED	118	PCU/(HR)(SQ FT)(DEG C)	
	TUBE SIDE		SHELL SIDE
*FLUID	PROCESS		COOLANT
RATE, AVG.	70000	LBS./HR.	94000
*RATE, MAX.	82000	LBS./HR.	110000
*INLET TEMPERATURE	80	DEGREES C.	30
*OUTLET TEMPERATURE	60	DEGREES C.	45
NORMAL OPR. PRESSURE	40	P.S.I.G.	50
PRESSURE DROP	9.9	P.S.I.	12.9
VELOCITY	5.6	FT./SEC.	2.5
DENSITY	63.000	LBS./CU.FT.	62.400
SPECIFIC HEAT	1.00	PCU/(LB)(DEG C)	1.00
BULK VISCOSITY	.560	CPS.	.770
*ALL VISCOSITY	.560	CPS.	.770
CONDUCTIVITY	.310	PCU/(HR)(FT)(DEG C)	.356
FOULING FACTOR	.00250	(HR)(SQ FT)(DEG C)/PCU	.00300
FILM COEFFICIENT	1039	PCU/(HR)(SQ FT)(DEG C)	719
*ALL COEFFICIENT	1570	PCU/(HR)(SQ FT)(DEG C)	
CLEANING CYCLE	1	EXPECTED TIMES/YEAR	1

PERFORMANCE DATA NEED NOT BE SHOWN ON PURCHASE ORDER UNLESS RECORD IS DESIRED.
* INDICATES SUGGESTED MINIMUM INFORMATION FOR RECORD.

COOLER 1.1 3-20-57 RJA-OMM

INPUT DATA (PER SHELL):

	TUBE SIDE	SHELL SIDE
INITIAL VEL.	7.0	2.5
ALLOWED DROP	20.0	20.0
J CONSTANT	.023	.330
EXPONENTS:		
REYNOLDS NO	.200	.400
PRANDTL NO	.667	.667
VISC. RATIO	.140	.140
TUBE I.D.	.620	

TUBE LAYOUT CONSTANTS:

TUBE CLEARANCE, DA	.250
FRACTIONAL FREE AREA=F2	.490
DROP ACROSS TUBE EQN=K3	19.320

OUTPUT DATA (PER SHELL):

	TUBE SIDE	SHELL SIDE
REYNOLDS NO.	48113	18842
PRANDTL NO.	4.372	5.234
J TERM	.00254	.00643
VEL HEAD=PSI	.2115	
VEL HDS/PASS	6.30	
VEL HDS=TOT.	46.80	
DROP ACROSS TUBES		8.69
DROP ACROSS BAFFLES		4.18
LMTD		32.5
LMTD CORRECTION FACTOR		.95
NO. TUBES REQD (NO I.F.)		144
IGNORANCE FACTOR, %		30

Fig. 2

During the computation process, the computer is on its own. That is, it follows the prescribed program in a logical order. Instructions in the program keep the computer from "spinning its wheels."

Sequentially, we compute the heat load, the temperature difference and corrections for multipass flow. Based on an initial velocity, the Reynolds number and heat transfer coefficients are then computed. These numbers are combined to give an over-all coefficient and, subsequently, the required area.

The computer selects the proper number of passes and the baffle pitch to meet our pressure drop requirements. The selections are made from tube layout tables for TEMA standard shell sizes, covering many tube sizes, tube pitches and number of passes.

From time to time during a problem, the machine reports its progress in the form of intermediate results on a supervisory control printer. The operator needs such information to detect mistakes in the program or the input data or to show when the computer cannot get a solution. Through these progress reports the engineer observes the number of times the computer tries to get a solution to each individual portion of the program. Thus, experience is gained in the proper selection of input data.

Checks and Balances

In addition to pressure drop, we place other limits on exchanger characteristics. The computer must check calculated results with these limits. For example, a baffle pitch of less than 2-in. is rejected, since past experience indicates that a smaller baffle pitch is not practical. We also require that whenever possible the pressure drop in the baffle window area be lower than the drop across the tube bank.

As another restriction, we will not let the machine repeat the pressure drop section of the program more than five times, since our past experience shows that a solution should be reached before then. A failure to get an answer after five trials indicates the possibility of an error in the input tape, of poor judgment in selecting the initial velocity used to start the calculation, or that no satisfactory solution exists.

In any case, the computer allows the program to proceed to the next step and to obtain a selection for an exchanger if possible. We are notified by the control printer that

this test has failed. This notice warns us to examine the final result, if one is forthcoming. If the computed pressure drop is high by only a small amount, we might accept the solution even though it exceeds our desired maximum pressure drop.

When it is finished, the computer writes on the output tape all the results and data required to complete the thermal specification of the exchanger. It then resets and proceeds to the next problem.

Results, Plus Extras

Once the final exchanger selection is made, the next stage of the program edits the information obtained from the computer. The desired number of significant figures for each result is selected and shifted into the proper storage location on the output tape. The final product of the computation, as printed by the high speed printer from the output tape, appears as shown in Fig. 2.

This form contains all the thermal design information for the exchanger. At the upper left are the specifications of size, number of tubes, baffle pitch, etc. At the bottom left is shown the performance on which the size is based. The right-hand columns contain the details of the particular equations used in the solution. Since these data interest only the engineer, this portion of the form is removed before it is sent to a vendor.

The mechanical features of the unit such as nozzle sizes, arrangement and construction standards, and code requirements are attached in a separate form. These thermal and mechanical specifications become the basis for a quotation, if a new exchanger is to be purchased.

Take Your Pick

A unique feature of our program is this: After the one optimum solution is obtained, the machine proceeds to compute all the other solutions which also produce workable designs. We can automatically obtain solutions for any changes in the input data which we select in advance, such as different tube lengths, smaller number of shells and fewer tube passes.

A summary of the most important results from each solution is tabulated and printed as shown in Fig. 3. The engineer can inspect this summary sheet and select the unit most suited to his arrangement, if he does not desire the first or optimum solution. This summary can be eliminated if not wanted by merely inserting a code word in the input.

When solving a series of problems which are somewhat similar, it is not necessary to have a complete input data sheet for each problem. At the end of each problem we merely add those values which will change for the next problem. In many cases only two or three numbers change, which reduces input typing time.

Benefits, With Interest

There are several advantages of using computers for rating heat exchangers: (1) The machine can obtain many solutions rapidly and choose the optimum one, whereas a manual calculation will often stop at the first usable solution. (2) By approaching the optimum more closely, an investment saving may be realized, and a more satisfactory unit performance should result. (3) The machine does not make arithmetic mistakes and indicates input data errors on the control printer. Consequently, it can work more quickly and get results to the designer in less time than manual computation. This reduction in elapsed time for plant design contributes to earlier start-up—usually very important and worth considerable money. (4) Freeing the engineer from routine problems which the computer can handle permits him to direct his efforts toward better over-all design of installations, as well as to problems which cannot be handled by a computer. (5) The costs of rating by machine versus manually are at least a break-even, and with experience they should be less on the computer.

This description of our program for rating heat exchangers gives only one example of the use of computers in chemical engineering calculations. We also use analog computers for problems in heat conduction, fluid flow and stress analysis. Multicomponent distillation calculations have been programmed on both analog and digital computers. Problems involving heat transfer, mass transfer and chemical reactions also have been explored on both analog and digital machines.

The programming of this example problem was done by D. M. Mraz. Other programs were developed by J. A. Beutler for both card and magnetic tape programs. R. J. Armstrong and A. C. Mueller also made considerable contributions in the development of the mathematical model used for the program.

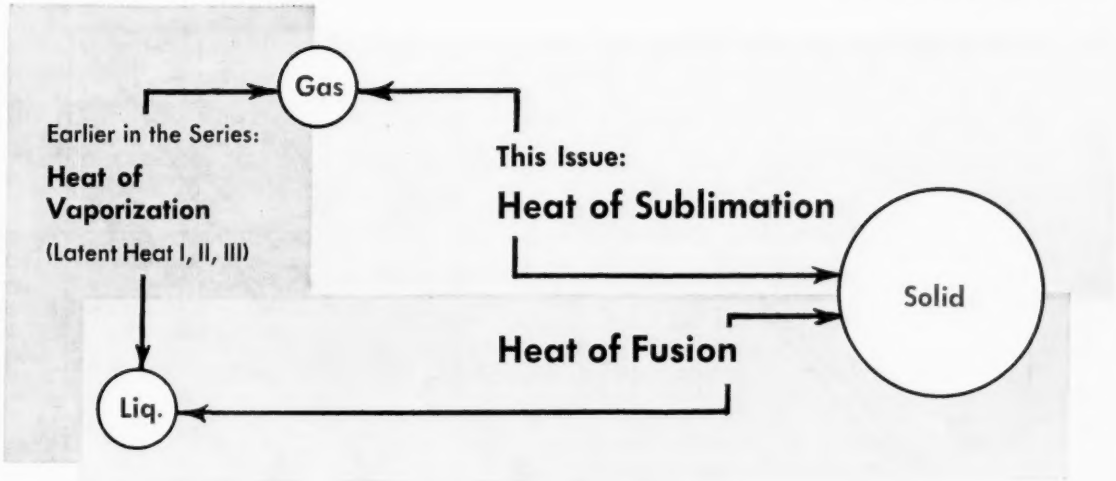
REFERENCES

1. O'Brien and Franks, "Application for General Purpose Analog Computer to Steady State Distillation Calculations". A.I.Ch.E Seattle Meeting, June 1957.
2. Alco Products Review—Fall 1956.

It's As Easy to Design a Dozen As One. **Fig. 3**

FAA/EP NO. 1000-100-1.1 KUA-0MM 3-20-57 P.1

TUBE LENGTH	NO. SHELLS	PASSES/SHELL	AREA/UNIT	SHELL DIA.	TUBE VEL.	TUBE DROP	SHELL VEL.	SHELL DROP	BAFFLE PITCH
16	1	6	584	17	5.6	9.9	2.5	12.9	6.5
16	1	4	591	17	3.7	3.2	2.5	12.9	6.5
16	1	2	622	17	1.7	.4	2.5	12.9	6.5
16	1	1	842	19	.6	.0	2.5	18.2	5.5
12	1	8	542	19	6.0	12.2	2.5	13.7	5.5
12	1	6	547	19	4.5	5.4	2.5	13.7	5.5
12	1	4	561	19	2.9	1.6	2.5	13.7	5.5
12	1	2	759	21	1.1	.1	2.5	14.5	5.0
12	1	1	942	23	.9	.0	2.5	16.1	4.5
8	1	8	562	23	3.9	4.0	2.5	10.8	4.5
8	1	6	572	23	2.8	1.7	2.5	10.8	4.5
8	1	4	697	25	1.6	.4	2.5	11.1	4.5
8	1	2	845	27	.6	.0	2.5	13.0	4.0



Find Heat of Fusion and Sublimation

WALLACE R. GAMBILL, Union Carbide Chemicals Co., Charleston, W. Va.*

We have three general ways to calculate the latent heat of sublimation, L_s. They are:

1. From the Clapeyron equation:

$$L_s = T(v_2 - v_1)(dP/dT)$$

Vapor pressures of solids are too small to measure at low temperatures and are usually measured over a small temperature range at a relatively high temperature level. This allows us to use more approximate forms of the Clapeyron equation with fair accuracy. For a fuller treatment of this subject see our earlier discussion in *Chem. Eng.*, Dec. 1957, p. 261.

2. From the relationship that the latent heat of sublimation is the sum of the latent heats of vaporization and fusion.

$$L_s = L_V + L_f$$

where the latent heats of phase change are all at the same temperature.

3. From the lattice theories of solid-state physics. This method is beyond the scope of engineering calculations and we'll not treat it here.

* Mr. Gambill is now with the Union Carbide Nuclear Co., Oak Ridge, Tenn. To meet your author see *Chem. Eng.*, Feb. 10, 1958, p. 173.

At low temperatures, where the vapor is approximately an ideal gas, we can use this approach:

$$dL_s/dT \approx (C_{Pg} - C_{Ps})$$

where the C's are molar heat capacities for vapor and solid, respectively.

To Calculate Fusion

The Clapeyron relation may not be simplified for the case of fusion as it may for vaporization and sublimation, since in this case v_s and v_l are of the same order of magnitude. Note also that (dP/dT) for the fusion curve is determined by the $(v_l - v_s)$ term in the Clapeyron relation.

If, as usually happens, expansion accompanies melting, v_l is greater than v_s and dP/dT is positive. However, for water (which contracts upon melting) v_l is smaller than v_s and dP/dT is negative.

Since data for the variation of melting point with pressure are available only in rare instances, the Clapeyron equation for fusion would more often be used for calculating change of melting point with pressure from known values of L_f and known volumes. For moderate pressure ranges—say 20 atm., or so—L_f and v may be considered to be constants.

A good data source for latent heats of fusion is *Bur. of Mines Bulletin 393* (1936) by K. K. Kelley, titled "V. Heats of Fusion of Inorganic Substances."

Unlike heat of vaporization, L_f increases with temperature. The exact thermodynamic relation for dL_f/dT along the saturation curve (pressure also varying) is:

$$dL_f/dT = (C_{Pl} - C_{Ps}) + (L_f/T) - (L_f/\Delta v)[d(\Delta v)/dT]_P$$

where

$$\Delta v = v_l - v_s$$

and which reduces to the good approximation that:

$$dL_f/dT \approx \Delta C_P + (L_f/T_f)$$

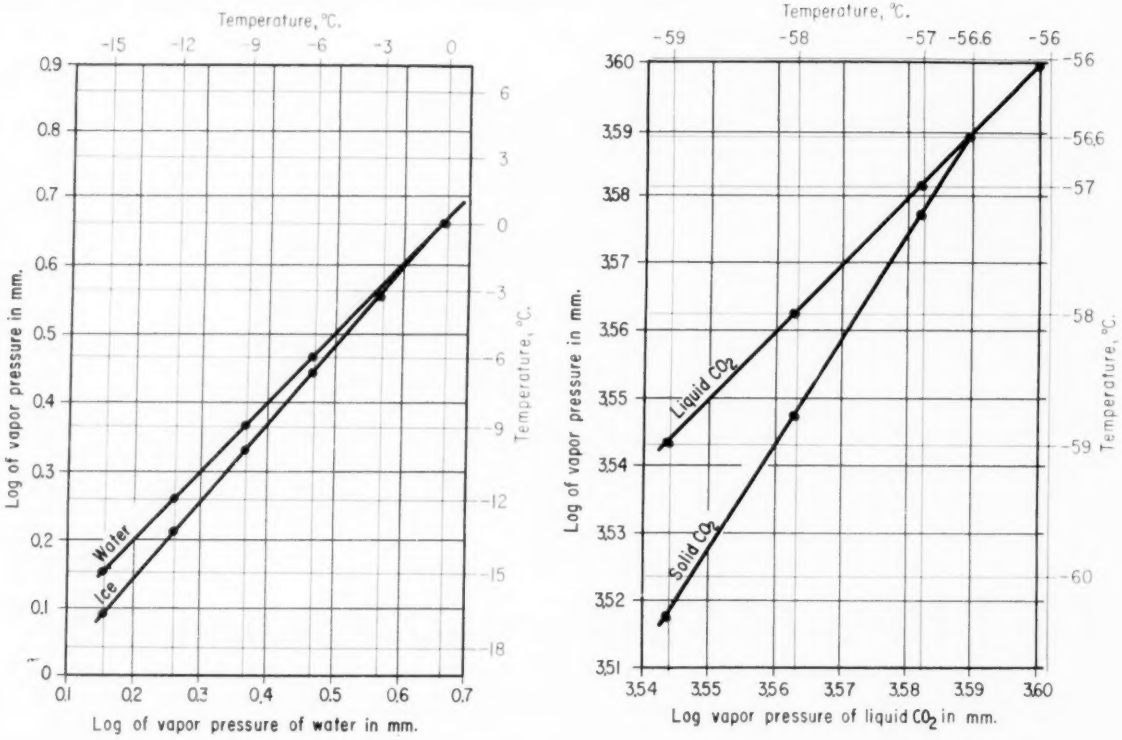
Pressure vs. Melting Point

An empirical rule by Johnston in *JACS*, Vol. 34, p. 788 (1912), may also be used to estimate effect of pressure on melting point:

$$\frac{\Delta T_f}{\Delta P} = \frac{T_f}{41.3 L_f \rho_s}$$

where ΔT_f = change of melting

Here's the Best Way to Approach Heat of Fusion Calculations



point, deg. K. or deg. C.; ΔP = change of pressure, atm. abs.; T_f = normal melting point, deg. K.; L_f is heat of fusion, cal./gram, at T_f; and ρ_s = density of the solid, grams/ml., at T_f.

Best Method: Othmer's

Othmer, in *Ind. & Eng. Chem.*, Vol. 32, p. 841 (1940), has proposed what is probably the only accurate and practical general method for calculating latent heats of fusion.

If we make a log-log plot of the vapor pressure of both the liquid and solid phases of a substance on the ordinate vs. the liquid-phase vapor pressures on the abscissa, each point of each curve corresponding to the same temperature, the plot will look something like those shown above for water and CO_2.

The slope of the liquid line is unity, since the vapor pressure of the liquid has been plotted against itself. The slope of the "solid line", denoted by m_s, is related to the heat of sublimation, L_s. It may be shown that the difference of the slopes, $m_s - 1$, is related to the latent heat of fusion of the solid by the following equation:

$$L_f = (m_s - 1)(L_V)_{Tf} \qquad (1)$$

where $(L_V)_{Tf}$ is the latent heat of vaporization of the substance at its melting point, T_f.

Alternatively, we may plot log of vapor pressure (liquid and solid) for the unknown vs. the same quantities for a reference substance, all points being at equal temperatures. This procedure requires extrapolating the liquid line into the supercooled region. For this method,

$$L_f = (m_s - m_l)(L_{VR})_{Tf} \qquad (2)$$

where m_l is the slope of the liquid line; and L_{VR} is the latent heat of vaporization of the reference substance.

Without data on the vapor pressure of the solid phase, one must resort to the following empirical methods.

Some Empirical Methods

Empirical approaches to the calculation of latent heat of fusion are, in general, of qualitative value only and none of the results can be generalized with much accuracy.

Most of the empiricisms equate the molar entropy of fusion, L_f/T_f, to a constant. T_f may be roughly approximated by the relation that T_f is nearly equal to 0.42 T_b, if need be.

Method 1—Tammann

For metallic elements, Tammann [*Z. phys. chem.*, Vol. 85, p. 273 (1913)] proposed this relation:

$$L_f/T_f = 2.2$$

where L_f is in gram-cal./gram-atom; and T_f is the melting point, deg. K.

The constant actually varies from 2 to 3, but experimental values for the elements can usually be found in the literature.

Method 2—Turkdogan-Pearson

Turkdogan and Pearson [*J. Appl. Chem.*, Vol. 3, p. 495 (1953)] proposed a more generalized scheme which may also be applied to com-

pounds; the results are based on data for inorganic substances exclusively.

If ΔT is defined as $(T_f - 298)$ in deg. K., the results of this method may be put in this simple tabular form:

ΔT	L_f/T_f
0	1.9
300	2.5
700	3.0
1,200 or more	3.2

where L_f/T_f is atomic entropy of fusion for elements, with units of cal./gram-atom-°K.

For inorganic compounds, the units are cal./mean-gram-atom-°K., where the ratio "grams/mean gram-atom" or "mean atomic weight" is obtained by dividing the molecular weight by the number of atoms in the structural formula of the molecule.

As an example of this method, let's calculate the latent heat of fusion for NaCl at 801 C. (1,074K.). The molecular weight is 58.5 and the mean atomic weight is 29.3 grams/mean gram-atom. $(T_f - 298) = 778$ K. From the table above, L_f/T_f is about 3.05 cal./mean gram-atom-°K. Therefore, L_f is about 6,540 cal./gram-mole.

A reported experimental value is 7,210 cal./gram-mole. This would be an error in calculation of about 10%.

With reference to the entropy of fusion of a physical mixture of elements such as an elemental alloy, it has been established that if the mixture is completely disordered, its heat of fusion may be calculated by regular additivity methods—i. e., weighting by component concentrations.

Method 3—Walden's Original

The original rule for compounds, equivalent to Tammann's for elements, was Walden's proposal in *Z. Elektrochem.*, Vol. 14, p. 712 (1908):

$$L_f/T_f = 13.5 \text{ cal./gram-mole-°K.}$$

This is nearly exact for many groups of compounds, but not for such a common class as the normal paraffins for which L_f/T_f increases with increasing molecular weight. $AlCl_3$, with the highest value of L_f/T_f known to this writer (18.2) deviates by 35% from Walden's rule.

Wenner, as stated in "Thermochemical Calculations," McGraw-Hill Book Co., p. 24, prefers using 9 to 11 as the constant for organic compounds and 5 to 7 for inorganics. Further, Wenner points out that if a given entropy of fusion is unusually low, there is often an entropy of transition for the solid state below T_f; and that this entropy of transition is of such a magnitude as to put the sum into the usual range. For HCl, as one example, $L_f/T_f = 3$, L_t/T_t is also 3 and the sum equals 6. This value is in the expected range.

Method 4—Gambill

We have derived the following empirical relation for nonaromatic organic solids containing only carbon, hydrogen and oxygen. It is especially applicable to the organic acids.

$$L_f/T_f = 4.95(10)^{0.00324M}$$

where M is the molecular weight of the solid.

This writer has also partially checked these forms:

$$L_f/[\text{P}] = \text{a constant}$$

and

$$\frac{L_f T_c (V_c)^{0.5}}{T_f^2[\text{P}]} = \text{a constant}$$

with fair success. Assignment to other problems has prevented this investigator from completing the correlation, and someone wishing to continue this work might find one of the two forms general enough to be useful. In these equations, [P] is the parachor, T_c is critical temperature and V_c is critical volume of the compound.

Heats of Ab- and Adsorption

Heats of absorption of the common light gases in organic liquids are within the range of 0.5 to 5.0 kcal./gram-mole, with about 2 kcal./gram-mole as a fair average.

For either absorption or adsorption, the heat effect will be greater than or equal to the latent heat of liquefaction of the gas at the given temperature.

The equilibrium between solid and adsorbed gas or vapor can be represented in many cases by the following form of the Clausius-Clapeyron relation:

$$\ln\left(\frac{p_2}{p_1}\right) = \frac{L_{ad}}{R}\left(\frac{T_2 - T_1}{T_2 T_1}\right)$$

where p_2 and p_1 are the equilibrium pressures in the gas phase corresponding to the adsorption of the same quantity of gas at T_2 and T_1 respectively; and where L_{ad} = "isoteric" heat of adsorption.

As used here, "isoteric" means that ΔH is based on the change of gas pressure with temperature at constant amount adsorbed (higher P for higher T with amount constant), instead of the change of quantity of adsorbed gas with temperature at constant pressure (less quantity at higher T and constant P).

If the adsorption is physical (only van der Waals attractive forces between the gaseous adsorbate and solid adsorbent), L_{ad} will seldom exceed L_v for the vapor by more than 50-100%, and will sometimes be nearly equal to L_v, particularly after completion of the first monolayer. For chemical adsorption, as on active catalytic surfaces L_{ad} can be very much more than L_v, perhaps 10 to 100 kcal./gram-mole of gas adsorbed.

For application of the reference-substance method of correlating adsorption variables, see Othmer and Josefowitz in *Ind. & Eng. Chem.*, Vol. 35, p. 1,269 (1943).

As described elsewhere in this section, this method is quite general, accurate and convenient for the correlation of many physical variables.

Heat of Solution

The exact Clapeyron equation gives the relationship between heat of solution and vapor pressure if P is interpreted as the vapor pressure of the volatile component over the solution and L as the molar heat of vaporization from the solution.

Burrows in *J. Appl. Chem.*, Vol. 4, p. 394 (1954) gives a simple semi-empirical relation for the heats of gas evolution from low vapor-pressure liquids at 298 K., involving only the molecular weight of the gas.

Coming Soon

Next subject will be methods that you can use to estimate surface tension. Watch for it in a forthcoming issue.

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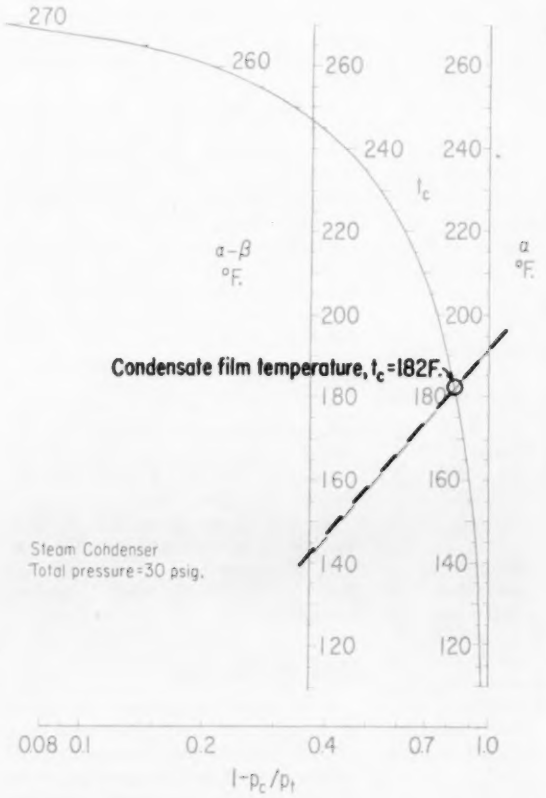
When Non-Condensables Are Present . . .

Make a Nomograph



Vapor Pressure of Water

t_v,F.	p_v, psia.	$1 - p_v/p_t$*
100	0.95	0.979
120	1.69	0.962
140	2.89	0.935
160	4.74	0.894
180	7.51	0.832
200	11.5	0.742
220	17.2	0.616
240	25.0	0.441
260	35.4	0.208

* p_t = 44.7psia.

Here's a "do-it-yourself" nomograph that eliminates certain trial-and-error solutions during the design of condensers.

F. RODRIGUEZ, Graduate Student and J. C. SMITH, Prof. of Chemical Engineering, Cornell University, Ithaca, N. Y.

THE NEED for dealing with a thin film of inert gas, as well as films of condensate, cooling water and scale, often greatly complicates condenser design. Calculations must take account of the fact that the molecules of condensing substance must diffuse through the layer of non-condensables to reach the condensate film.

A rigorous method of solving the general problem calls for equating the heat flow towards the condensate surface to that away. Heat flow to the surface at any point is the sum of (1) sensible heat removed from the gas as a result of temperature difference and (2) latent heat carried into the condensate by vapor diffusion. Heat flow away is that picked up by the cooling medium.

Colburn and Hougen[3] devised a method, following these generalizations, for determining necessary condenser area for any particular design problem. It is based on the equation:

$$h_o (t_v - t_c) + KM \lambda (p_v - p_c) = h_i (t_c - t_w) = U\Delta t$$

Solution involves trial-and-error calculations of point temperatures t_c at the condensate surface for selected values of bulk-gas temperature t_v. Reciprocal values of the heat flux $U\Delta t$ for each point are then plotted against heat transfer to that point, and the area of the condenser surface found by graphical integration.

The method, however, is very time-consuming. So, for those interested in cutting corners without significant loss of accuracy, here's a blueprint for a nomograph that eliminates the trial-and-error step. The

Nomenclature

- h_i = Heat transfer coefficient between cooling water and surface of condensate film, including resistances of water, scale, metal wall, and condensate; Btu./(hr.) (ft.^{2}) (°F.)
- h_o = Gas-film coefficient of heat transfer between vapor-gas mixture and condensate surface, Btu./(hr.) (ft.^{2}) (°F.)
- k = Arbitrary parameter, lb. moles/(hr.) (ft.^{2})
- K = Mass transfer coefficient, lb. moles/(hr.) (ft.^{2}) (atm.)
- M = Molecular weight of condensing vapor.
- p_c = Vapor pressure of condensate at temperature t_c, atm.

to Find Condensate Film Temperature

method is not as elaborate as that proposed recently by Bras,[2] but it is more convenient.

Nomograph Construction

Recommended procedure for construction is:

1. Label the arithmetic axis of a sheet of semi-log graph paper with a range of temperatures somewhat larger than that expected for the condensate film.

2. Calculate the value of the term $1 - (p_c/p_t)$ for several temperatures spanning those labeled on the arithmetic axis. Label the logarithmic axis to cover the range of these calculated values.

3. Plot $1 - (p_c/p_t)$ vs. temperature.

4. With a straightedge drop a line, parallel to the temperature axis, to a value of 1.0 on the abcissa; drop another to 0.368. Label the lines α and $\alpha - \beta$, respectively. Subdivide each line into the same scale as that of the temperature axis, and label correspondingly.

Two-cycle or three-cycle semi-log paper in long rolls is ideal for this construction since it affords an adequate range of $1 - (p_c/p_t)$ and a limitless range of temperatures.

Using the Nomograph

To estimate film temperature for a given condenser configuration:

1. Calculate[4] values for h_i, h_o, k and t_w from basic design data and the chosen t_v.

2. Calculate α and β from:

$$\alpha = \frac{h_i t_w + h_o t_v - kM\lambda \ln (1 - p_v/p_t)}{h_o + h_i}$$

$$\beta = \frac{k\lambda M}{h_o + h_i}$$

3. Connect values of α and $\alpha - \beta$ on nomograph with a straightedge. The intersection of the straightedge with the plot of $1 - (p_c/p_t)$ vs. t_c gives the condensate film temperature t_c, corresponding to the value of t_v used.

Example—Kern[4] gives an example of a steam condenser containing carbon dioxide at a total pressure of 30 psig. For an intermediate point where $t_v = 262$ F., he calculates: $h_i = 926$, $h_o = 15.0$, $k = 2.80$, $t_w = 103.3$ and $p_v/p_t = 0.816$. These values give $\alpha = 190.9$, $\beta = 50.2$, and thus $\alpha - \beta = 140.7$. The nomograph (see opposite page) has been plotted from vapor-pressure data shown in the tabulation. Connecting α and $\alpha - \beta$ gives $t_c = 182$ F. This is the same answer that Kern obtains by trial-and-error solution.

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2. Bras, G. H. P., *Chem. Eng. Science*, **6**, 277 (1957).
3. Colburn, A. P., and O. A. Hougen, *Ind. Eng. Chem.*, **26**, 1178 (1934).
4. Kern, D. Q., "Process Heat Transfer," 339-352, McGraw-Hill Book Co., Inc., New York (1950).

Nomograph Derivation

Derivation of the nomograph starts with the generalized equation of Colburn and Hougen*

$$h_o (t_v - t_c) + KM\lambda (p_v - p_c) = h_i (t_c - t_w) = U\Delta t \quad (1)$$

Known quantities are separated from unknown by defining K in terms of pressure and an arbitrary parameter k, as follows:

$K = k/p_m$ where p_m is given by

$$p_m = \frac{(p_t - p_c) - (p_t - p_v)}{\ln (p_t - p_c/p_t - p_v)} = \frac{p_v - p_c}{\ln [(1 - p_c/p_t)/(1 - p_v/p_t)]}$$

Eq. (1) can now be written:

$$h_o(t_v - t_c) + kM\lambda \ln[(1 - p_c/p_t)/(1 - p_v/p_t)] = h_i(t_c - t_w) \quad (2)$$

If a vapor temperature t_v is assumed, all variables in Eq. (2) are fixed except t_c and p_c. Multiplying the terms within the parentheses of Eq. (2) by those outside, and then substituting parameters for the fixed variables, the expression becomes:

$$\alpha - t_c + \beta \ln (1 - p_c/p_t) = 0 \quad (3)$$

where

$$\alpha = \frac{h_i t_w + h_o t_v - kM\lambda \ln (1 - p_v/p_t)}{h_o + h_i} \qquad \beta = \frac{k\lambda M}{h_o + h_i}$$

The two remaining variables in Eq. 3, p_c and t_c, are related by the fact that p_c is the vapor pressure of the condensate at temperature t_c.

Eq. 3 can also be described by the determinant:

$$\begin{vmatrix} \alpha & 0 & 1 \\ \alpha - \beta & -1 & 1 \\ t_c & \ln (1 - p_c/p_t) & 1 \end{vmatrix} = 0$$

To set up the nomograph[1] for a given vapor condensing at a given total pressure, t_c is plotted vs. $\ln(1 - p_c/p_t)$ where p_c is the equilibrium pressure of the condensing vapor at temperature t_c. This can be done most conveniently on semi-log paper. Temperature axes for α at $(1 - p_c/p_t) = 1.0$ and for $\alpha - \beta$ at $(1 - p_c/p_t) = 0.368$ complete the chart. These correspond to the natural antilogs of 0 and -1.

p_t	Total pressure in system, atm.
p_v	Partial pressure of condensing vapor in bulk of vapor-gas mixture at temperature t_v, atm.
p_m	Logarithmic mean of partial pressure of non-condensing gas in bulk of gas and at condensate surface, atm.
t_c	Temperature at condensate surface, °F.
t_v	Temperature of bulk of vapor-gas mixture, °F.
t_w	Temperature of cooling medium, °F.
Δt	True temperature difference, $\Delta t = t_v - t_w$.
U	Over-all heat transfer coeff., Btu./(hr.) (ft.^{2}) (°F.)
α, β	Arbitrary parameters.
λ	Latent heat of condensing vapor, Btu/lb.

* Note: The heat transfer and mass transfer coefficients in this equation must all be based on the same surface area.

How to Allocate Process Steam Costs

Use methods shown here to calculate unit costs of steam when source is waste heat recovery units or multiple extraction from turbines.

S. KATELL, Supervisory Chemical Engineer and T. J. JOYCE, Chemical Engineer, U. S. Bureau of Mines, Morgantown, W. Va.*

ALLOCATION of steam costs between process steam requirements and electrical power generation is frequently encountered in many chemical plants. In this article, we show some simplified techniques to obtain accurate process steam costs. These methods enable you to make comparisons of the unit costs of steam obtained from various sources.

There are usually three sources of steam in the integrated chemical plant. The first is steam obtained from a steam boiler installation. A second source is steam extracted or exhausted from either a turbo-generator or the turbine and piston-engine drives used on compressors or pumps. The third source is from waste-heat boiler steam. To add to the complexity of the problem, most plants require process steam at varying levels of pressure and temperature.

Use Steam Rates to Find Costs

From a cost engineering standpoint, one of the simpler cases to resolve is one in which process steam at one or more levels is available from a power plant unit. For illustration let's consider, the following hypothetical steam plant which is located in the upper Ohio River valley:

1. Steam production: 3 MM lb./hr. at 1,400 psig. and 950 F.
2. Power plant production: 275,000 kw. plus 45,000 lb./hr. steam extracted at 375 psig. and 870,000 lb./hr. steam extracted at 50 psig.
3. Estimated annual operating cost of integrated steam-power plant with coal charged at $4/ton is $11,420,000.

The annual operating cost of $11,420,000 is the cost after taking credit (as detailed later) for extracted steam. On this basis, power cost are equal to 5.2 mills/kwh. This cost includes depreciation charges, but no return on investment.

Isolating the high pressure (1,400 psig.) steam production costs results in an annual cost of $8,800,000 which is equivalent to 37¢/1,000 lb. of steam produced.

One of the methods that may be used in establishing the credit for the extracted steam requires the basic assumption that the steam, if not extracted, can be used to produce power. To find these values, it is necessary to determine the steam rates (sometimes called water rates) for the specific conditions involved.

The term ideal steam rate denotes the quantity of steam necessary to develop one kwh. Actual steam rates can be obtained by dividing the ideal steam rate by the efficiency of the steam engine or turbine. Expressed in terms of mechanical equivalent, the steam rate equals $3,413/\Delta H \times$ efficiency. Here ΔH represents the difference in enthalpy between initial and final steam conditions. Also one kwh. of electrical energy is equivalent to 3,413 Btu.

For the operating variables assumed in our hypothetical plant, we have the following additional information. Enthalpy of throttle steam at 1,400 psig. and 950 F. equals 1,461 Btu./lb.; enthalpy of steam to condenser at 2 in. Hg abs. equals 886 Btu./lb.; $\Delta H = 575$ Btu./lb. and turbine efficiency is 68%.

The actual steam rate for the 1,400 psig. steam is equal to $3,413/(575)\ (0.68) = 8.7$ lb./kwh. Similarly, the values for the 375 psig. and the 50 psig. steam when condensed at 2 in. Hg abs. are 12.4 and 21.3 lb./kwh. respectively.

Therefore, using the steam rates and a steam cost of 37¢/M lb., the extracted steam costs are calculated as follows:

For 375 psig. steam: $37¢ \times 8.7/12.4 = 26¢$/M lb.
For 50 psig. steam: $37¢ \times 8.7/21.3 = 15¢$/M lb.

Use Heat Basis to Allocate Steam Costs

In a recent article,[1] R. J. Martin discusses another approach to the apportionment of process steam costs. He proposes allocation on a Btu. basis. In the above example, using condensate at 14.7 psia. and 32 F. as the zero enthalpy base, the heat content of the high pressure steam is 1,461 Btu./lb. Condensate returned to the boiler at 290 F. has a heat content of 258 Btu./lb. The heat added in the steam generating plant is 1,461 minus 258 or 1,203 Btu./lb. As previously found, the cost to produce this 1,203 Btu./lb. is 37¢ per 1,000 lb. of steam. This cost is equivalent to 31¢/MM Btu., where MM corresponds to one million.

Having thus arrived at a unit cost for heat, it is now necessary to calculate the heat content of the extracted streams. While the extraction pressure can be fixed, it is not possible to fix the extraction temperature absolutely because steam expansion in the turbine is not isentropic.

However, as Martin points out, it is possible to assume an equitable Rankine cycle efficiency. Assume the efficiency of the first stage at 65% and that of the second stage at 72.5% of the ideal Rankine cycle.

The heat available in the steam extracted at 375 psig. is therefore:

$$1{,}203 - [0.65(1{,}461 - 1{,}302)] = 1{,}100 \text{ Btu./lb.}$$

In the accompanying Mollier chart, line ABD represents the ideal Rankine cycle expansion of the steam. Line AC shows the actual expansion of the steam extracted at 375 psig. (390 psia.). The heat content of 1,000 lb. of steam is equal to 1.10×10^6 Btu. Therefore, the steam cost is 31¢/MM Btu. × 1.10 MM Btu./lb. = 34¢/M lb.

* Meet your authors on p. 184.

In the steam extracted at 50 psig., the heat available is:

$$1{,}203 - [0.725(1{,}461 - 1{,}142)] = 972 \text{ Btu./lb.}$$

Here line ACE in the Mollier chart represents the actual expansion of the steam extracted at 50 psig. (65 psia.). The steam cost equals 31¢/MM Btu. × 0.972 MM Btu./M lb. = 30¢/M lb. Taking credit for steam at these prices gives a resultant power cost of 4.7 mills/kwh.

Martin's method of cost allocation may be used in relation to waste heat recovery systems. Only the conversion costs, (utilities, labor, maintenance and fixed costs) normally are accounted for in waste heat recovery systems. No charge is made for heat to the unit since cooling of the process gas stream and not steam generation is usually the primary consideration. Unit steam costs, therefore will be much lower for waste heat recovery systems.

For example, annual operating cost of a unit to produce 500,000 lb./hr. of steam at 375 psig. and 700 F. from synthesis gas at 2,200 F. and 300 psig. has been estimated to be as follows:

Utilities	$17,800
Direct labor and supervision	68,000
Maintenance	64,800
Fixed costs (overhead and depreciation)	413,700
Total	$564,300

At a 90% load factor (330 days/yr.), the unit cost of steam is $564,300/500 × 24 × 330 = $0.14/M lb. This base price for steam may be interpreted in the following manner. It cost 14¢/M lb. to increase the enthalpy of the condensate feed to the waste heat boiler from 258 Btu./lb. to 1,363 Btu./lb. Therefore, it is equivalent to a unit cost of 13¢/MM Btu.

In addition, assume extraction of steam at 50 psig. and use a Rankine cycle efficiency of 80%. The enthalpy of the 50 psig. steam at the extraction temperature is

$$1{,}363 - [(1{,}363 - 1{,}186)0.80] = 1{,}221 \text{ Btu./lb.}$$

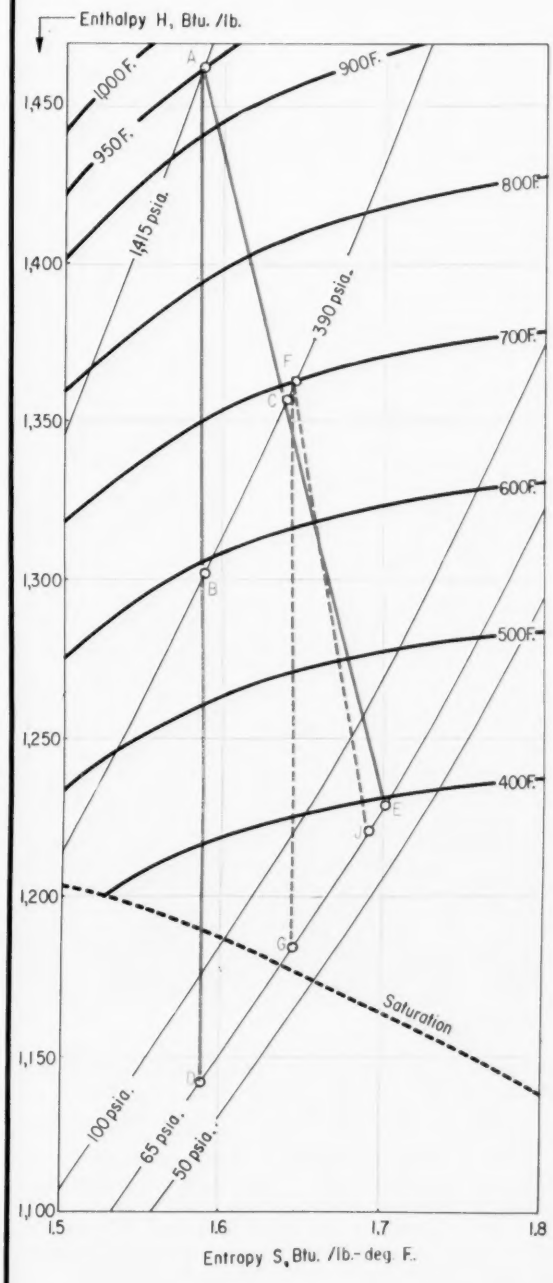
Referring to the Mollier chart, the ideal Rankine cycle for this case is shown by line FG. The actual steam expansion occurs along the line FJ.

Heat added to the condensate equals 1,221 − 258 = 963 Btu./lb. The unit cost of this steam is equivalent to

13¢/MM Btu. × 0.963 MM Btu./M lb. = 12.5¢/M lb.

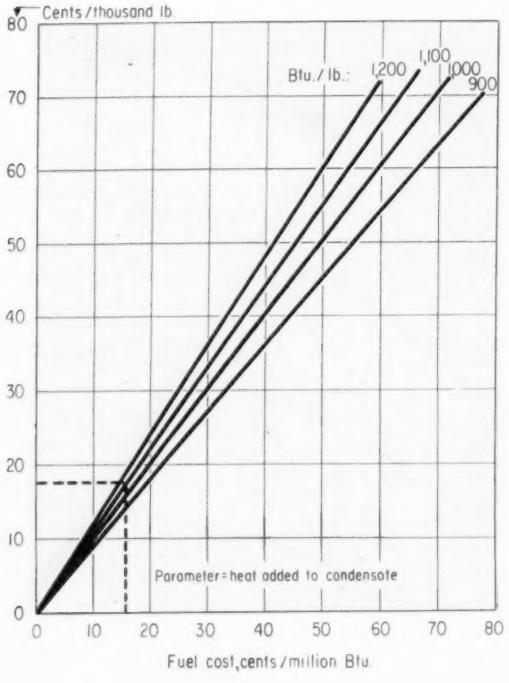
Basically, the cost of waste heat steam when calculated by this latter method does not include the cost of the energy which is transferred from the process stream to the steam. When a particular process unit does not consume all the energy produced in the process, one way to arrive at a cost balance is to credit the production unit with the portion of the energy that can be recovered. Consequently, the heat recovery unit can be charged with the portion of the energy that it delivers in the steam.

Use Mollier Chart for Steam Expansion



Point	H, Btu./Lb.	Point	H, Btu./Lb.
A	1,461	E	1,230
B	1,302	F	1,363
C	1,358	G	1,186
D	1,142	J	1,221

Heat Charge for Waste Heat Steam


Cents/thousand lb
Btu./lb.: 1,200 1,100 1,000 900
Parameter = heat added to condensate
Fuel cost, cents/million Btu
0 10 20 30 40 50 60 70 80

The heat value added to the condensate in a waste heat recovery system is shown in the figure on this page. Apply this chart to the previous example assuming that the primary source of heat energy is coal with a heating value of 12,500 But./lb. If coal costs $4/ton, the calculated fuel cost is then 16¢/MM Btu. Enthalpy added to the condensate is 1,105 Btu./lb. which from the chart shows a heat charge of 18¢/M lb. Thus the total charge to users of 375 psig. waste heat boiler steam is 14¢/M lb. plus 18¢/M lb. or 32¢/M lb.

If the basic fuel used by the plant is natural gas with a heat content of 1,000 Btu./scf., a gas price of 16¢/M scf. is equivalent to $4/ton coal. Here the same calculations apply.

An additional credit can be made to this type of installation for the work which is available from the steam when it expands from 375 to 50 psig. This work is equal to $(1{,}363 - 1{,}186)(0.8)(1{,}000)/3{,}413 = 41.6$ kwh./M lb. when it is extracted at 50 psig.

A third type of balanced utility installation can exist. In this case all the steam from the steam plant is used to generate power. Waste heat steam is recovered and utilized at two different levels, 375 and 50 psig. Estimated cost for a 375 psig. waste heat system, as detailed previously, amounts to 14¢/M lb.

Calculation of the cost of 50 psig. waste heat steam results in the following typical estimated annual operating cost:

Utilities	$8,200
Direct labor and supervision	68,000
Maintenance	57,500
Fixed costs (overhead and depreciation)	345,000
Total	$478,700

This is equal to a unit steam cost of 12¢/M lb. Depending on the cost system used, these results indicate that it may be more economical to recover the heat in waste heat boilers than to extract steam from a turbine. The difference may be offset if credit is taken for the power produced in the turbine.

It is evident that when estimating unit costs in a projected integrated plant the operating costs of the heat recovery units must be absorbed into the price charged for the steam produced by these units. When heat is recovered with the same total heat content per unit of recovery media, the unit price will often differ because of variations in size and type of equipment, operating labor and maintenance costs.

The estimator by judicious selection of the steam source can change the cost picture to favor one unit process operation at the expense of another. Hence, the best approach when preparing comparable cost estimates is to assume an average value for all steam with the same heat content.

The same reasoning applies to recovered steam at different levels. It is very possible that a direct unit cost for steam with available heat of 1,000 Btu./lb. to have a higher unit cost than steam that has 1,200 Btu./lb. of heat available.

The following example illustrates this point for waste heat recovery of steam at different levels. For case I, steam recovery is at 375 psig., 700 F. and enthalpy of 1,363 Btu./lb. For case II, steam recovery is at 325 psig., 500 F. and enthalpy of 1,253 Btu./lb.

	Case I	Case II
Utilities	$17,800	$12,500
Direct labor and supervision	68,000	68,000
Maintenance	64,800	57,600
Fixed costs	413,700	368,000
Total costs	564,300	506,100
Steam quantity	500,000 lb./hr.	350,000 lb./hr.
Unit steam cost	14¢/M lb.	18¢/M lb.

It is seen that the price charged for steam from both of these units must equal the total operating costs of $1,070,400/yr. Using the steam rate approach as described previously, the cost of the two levels of steam may be established. The heat available to produce electricity from the 375 psig. steam at 80% efficiency is 1,363 minus 1,005 or 358 Btu./lb. Heat available from the 325 psig. steam is 1,235 minus 916 or 319 Btu./lb.

Since the total operating cost must be absorbed by both units and unit costs are compared on an available heat basis, two equations are developed. Let X equal cost of 375 psig. steam, $/M lb. and Y equal cost of 325 psig. steam, $/M lb.

$$\$1{,}070{,}400 = X(500 \text{ M lb./hr.} \times 24 \text{ hr./day} \times 330 \text{ day/yr.}) + Y(350 \text{ M lb./hr.} \times 24 \text{ hr./day} \times 330 \text{ day/yr.})$$

$$\$1{,}070{,}400 = 3{,}960{,}000X + 2{,}772{,}000Y$$

$$X/Y = 358/319 = 1.122$$

Solving the equations gives $Y = \$0.15$/M lb. and $X = \$0.17$/M lb.

Costs calculated by this method are synthetic to the extent that they do not reflect the individual unit costs for the particular heat recovery units. However, this method is least likely to cause erroneous comparisons of the production unit operations.

REFERENCE

1. Martin, R. J., "Allocation of Heat in an Industrial Power Plant—A Practical Approach," *Mech. Eng.*, **79**, Aug. 1957, pp. 743-746.

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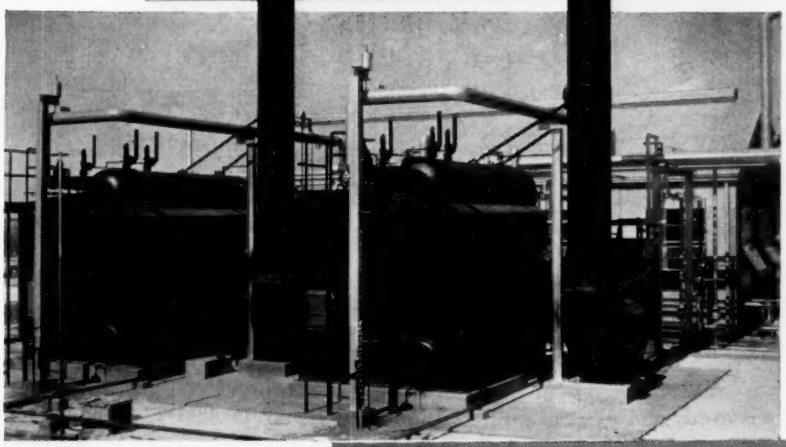

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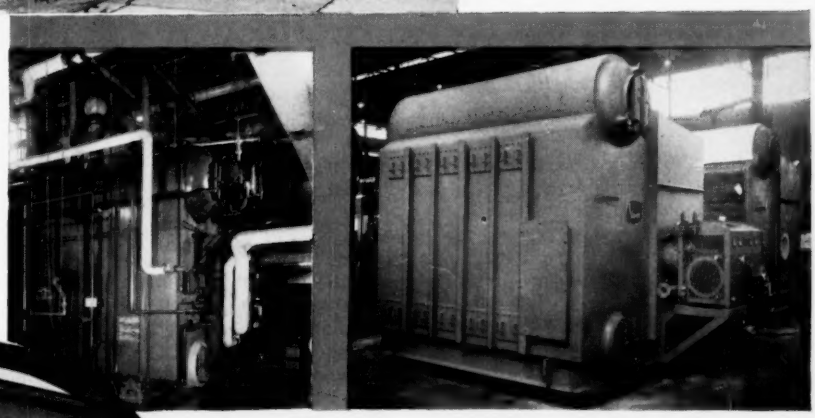

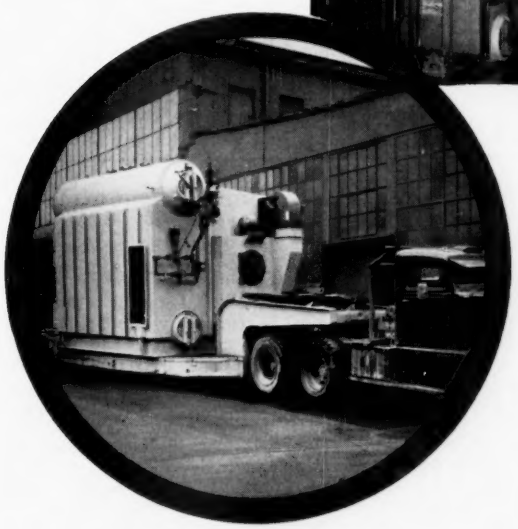

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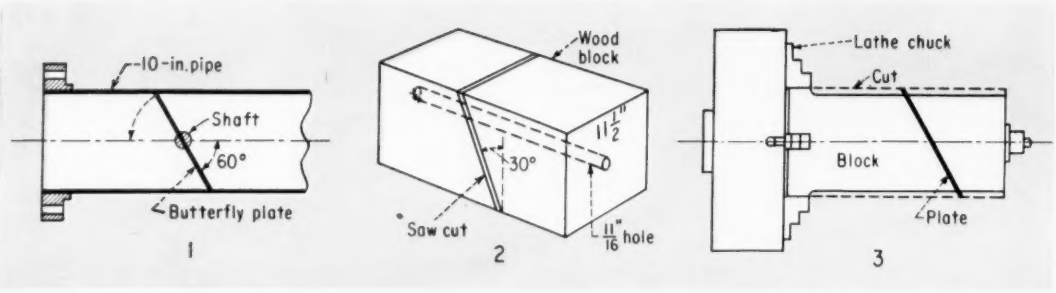

Make an Easy-to-Build Butterfly Valve

Although not widely employed, butterfly valves have uses in handling low-pressure fluids and even granular solids.

★January Contest Winner by
Chesman A. Lee
Engineer, Evanston, Ill.

Although butterfly valves are on the market, they are not widely used in process industry plants. Still, there are sometimes occasions when a plant may want to build its own. The design shown is easily constructed and is ideal for some low-pressure jobs.

Much improvised equipment is merely "make-do." However, this valve can be more than just good enough. It works well in regulating the flow of gases when a low differential is involved. It has been used successfully in handling granular solids. With the addition of stuffing boxes for the shaft it could be adapted to the regulation of low-differential liquids.

A valve for 10-in. Sch. 40 ips. pipe is sketched in Fig. 1. It consists of a length of pipe containing an elliptical butterfly plate, accurately machined to fit snugly when turned at 60° from the open position. The trick in getting the desired fit lies in the machining operation—or rather in the construction of a fixture for handling the job.

For the 10-in. valve take a block of 12 x 12 wood (11½ in. square) about 2 ft. long. Drill it centrally for a ⅝-in. rod with nuts at each end, then saw it diagonally at 30° from the vertical as in Fig. 2. The precision of the sawn surface can then be corrected as required and the two halves bolted together.

The bolted block is then chucked by its long end in a lathe and rough turned to 10¼ in. diameter. (I.D. of the 10-in. pipe is 10.020 in.) Then drill a hole centrally in a 11 x 15-in. piece of 12-ga. steel plate to fit diagonally on the ⅝-in. bolt when clamped in the saw cut.

Clamp the piece of steel plate between the blocks in position for marking. A chalk mark following the intersection of the plate with the 10¼-in. diameter wood cylinder produces an ellipse. Remove the plate and rough cut it for safety approximately to shape. Then reclamp the plate in position and finish turn both the block and the plate to a 10-in. diameter. From start to finish, the longer end of the block should remain in the lathe.

When the finished plate is removed it will be found to be a

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NEXT ISSUE: Watch for February Winner Announcement

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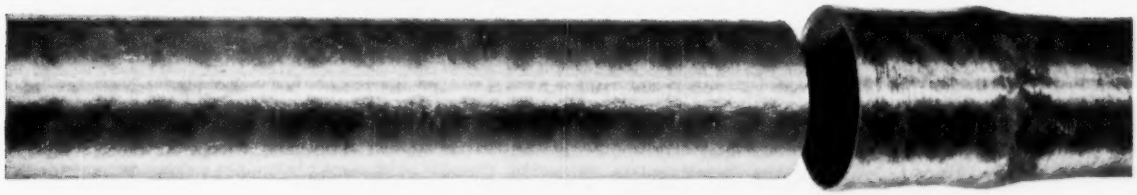

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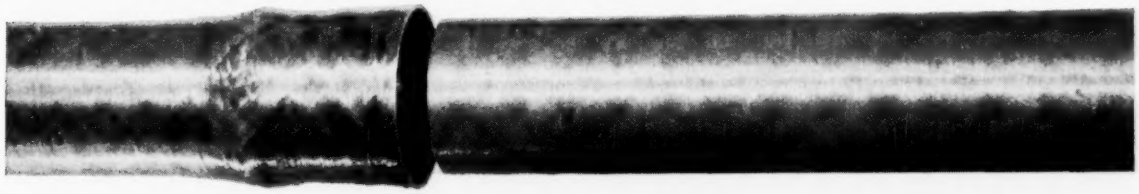
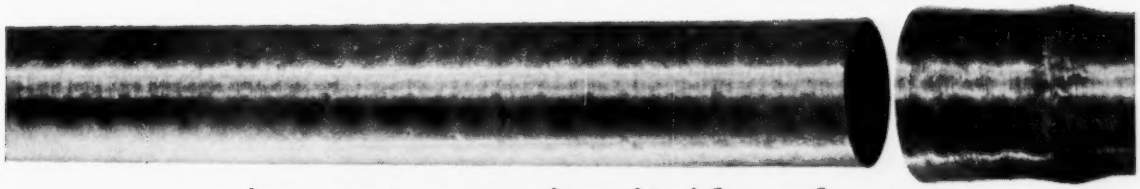
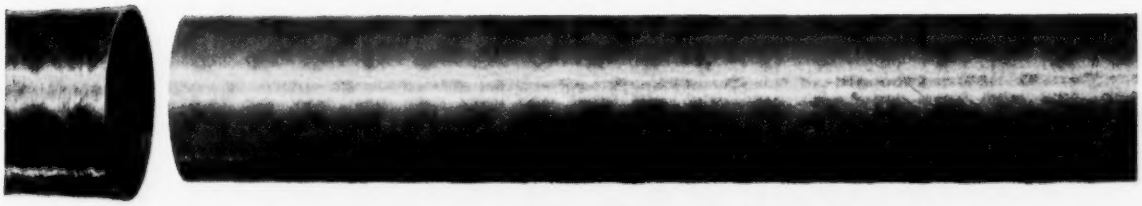


combination of light weight, high strength, and



resistance to corrosion, inside and out...



diameters from **2** *inches to* **40** *inches*

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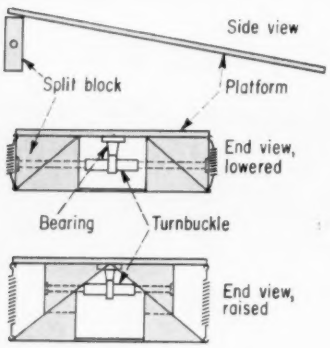
true ellipse which will fit snugly as required. For safety it is well to blunt the sharp edges. And if the valve is to be used for granular materials the edges must be thinned down on the long diameter.

The shaft can be made in various ways. A simple way, but perhaps not the best, is to slit a piece of 1-in. O.D. tubing and clamp the plate into the slot. An external quadrant and linkage can be easily worked out to suit the conditions.



Adjustable Platform Aids Material Loading

E. J. and C. A. Erwood
Chicago 44, Ill.

Loading and unloading into box cars is seldom much of a problem since the height of the car floor is standard. But when it is necessary to truck materials from the loading dock into road vehicles, beds of which are quite variable in height, an adjustable loading platform is a handy thing to have around. The sketch above shows one way to construct such a platform.

The supporting blocks are split diagonally and the distance apart of the upper halves is controlled by a turnbuckle-like arrangement of right- and left-hand threaded rods joined by a threaded tie coupling. The latter is secured to the platform by a pedestal bearing. The lower blocks can be joined together at the bottom and secured to the platform by springs. Adjustment of the height is made by reaching under the end of the platform and turning the tie coupling by hand or with a wrench.

Calculate Height of a Fluidized Bed

A. W. Francis and D. J. Carbone
Chemical Construction Corp., New York.

Height of a fluidized bed is difficult to determine by direct measurement. This problem can be circumvented by calculation from two measured quantities, the pressure drop across the bed, and the bed density taken at some representative location in the bed.

When the pressure drop across the bed is measured in inches of liquid column, then

$$\rho_c h_c = (h_w/12)\rho_w \qquad (1)$$

where h_c is the height of the fluidized bed, ft.; ρ_c is the density of the fluidized bed, lb./cu. ft.; h_w is bed pressure drop, in. of liquid column; and ρ_w is the density of the manometer liquid, lb./cu. ft. If the liquid is water, 62.4 lb./cu. ft., then

$$h_c = (62.4/12)\, h_w/\rho_c$$

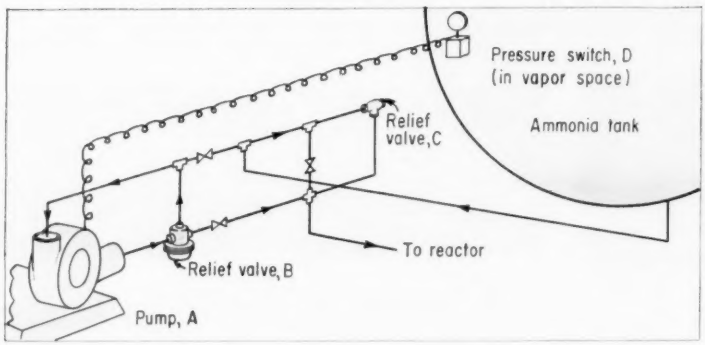
or

$$h_c = 5.2\, h_w/\rho_c \qquad (2)$$

With a water manometer, if the pressure taps are spaced 62.4 in. apart, then h_c has this value and cancels ρ_w, so that $\rho_c = h_w'$, that is, the reading in inches of water across taps spaced 62.4 in. apart. So, substituting h_w' in Eq. (2) for its equivalent ρ_c we get

$$h_c = 5.2\, h_w/h_w' \qquad (3)$$

As an example, if the bed pressure drop h_w is 70 in. w.c., and the pressure h_w' for taps 62.4 in. apart is 14 in. w.c., then $h_c = 5.2 \times 70/14 = 26$ ft.



Handling Volatile Liquids From Storage

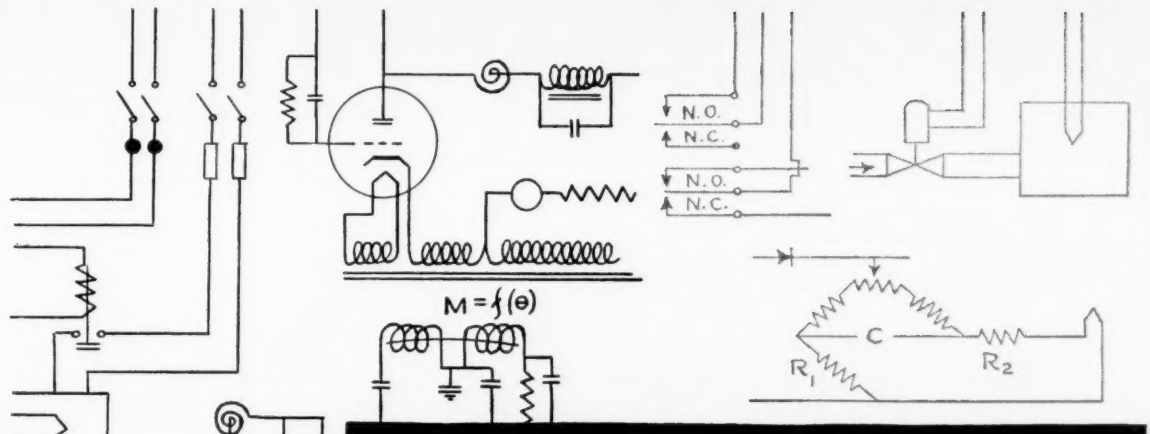
Douglas MacGregor
Chemical Engineer, Western Phosphates, Inc., Garfield, Utah.

In our plant we had the problem of supplying anhydrous liquid ammonia from our storage tanks to our reactor. It was necessary to do so at more than a specified minimum pressure. However, we have great seasonal variations in temperature and at low ambient temperatures the vapor pressure of the ammonia would fall far below the required minimum pressure.

We solved this problem as shown in the sketch above. The set-up consists of a positive displacement pump *A*, a network of piping and valves, and two relief valves. That at *B* is a Cash-Standard No. 123 (A. W. Cash Co., Decatur, Ill.), while the other, at *C*, is a standard relief valve.

Operation of this system is as follows: A pressure switch *D* mounted on the ammonia storage tank turns on the pump *A* if the tank pressure is low. The pump then discharges anhydrous ammonia to the reactor.

In the case of low utilization rate or shutdown, relief valve *B* opens and the liquid goes into partial or complete recirculation through the riser from *B*.



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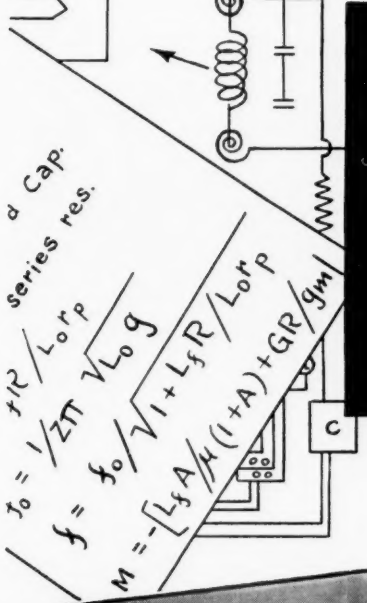

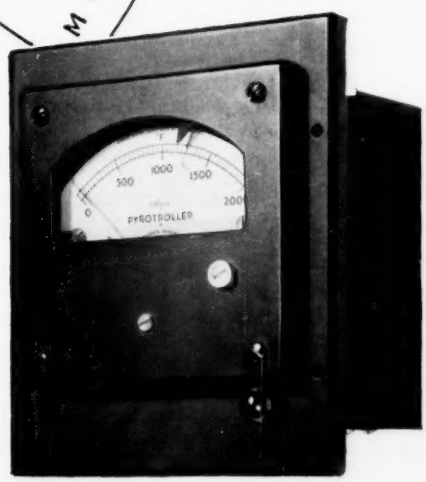

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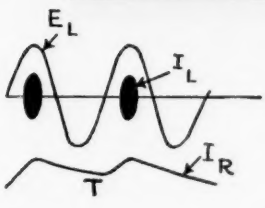
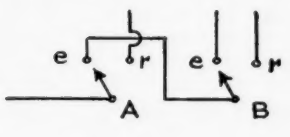
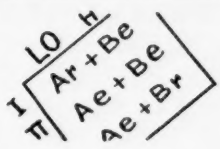
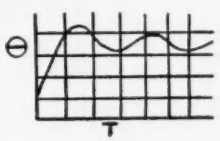


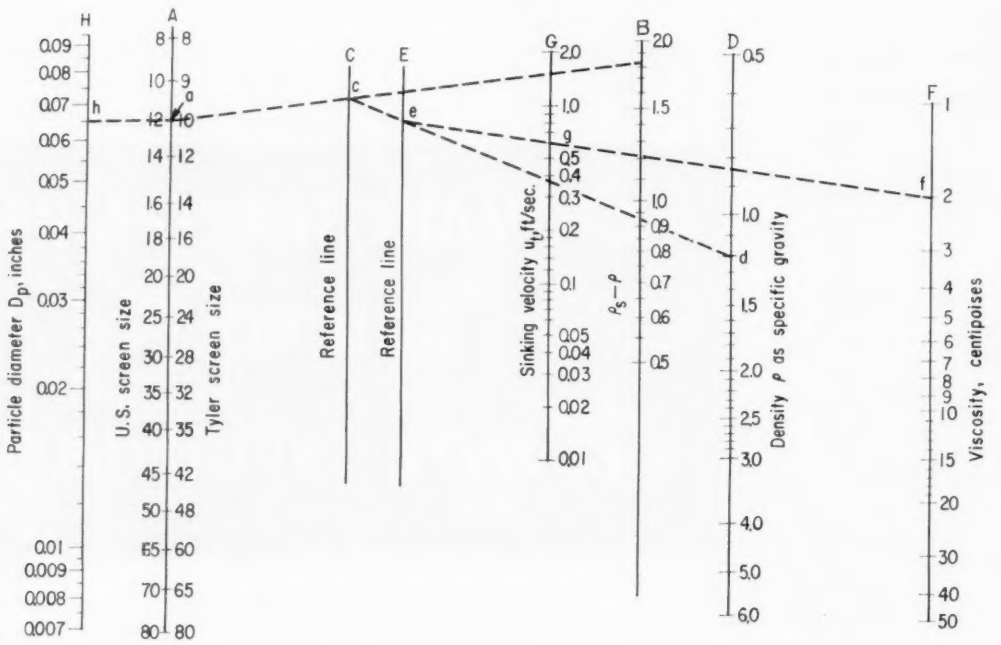






If tank pressure is high enough, the pressure switch turns off the pump and liquid discharges through the second relief valve *C*.

Low-boiling liquids should be drawn from the bottom of the tank because boiling may take place in a siphon.



Nomograph Gives Settling Velocity

M. Rhoden
Process Engineer, Diamond Alkali Co., Painesville, Ohio.

The engineer is often confronted with the problem of estimating settling velocities of particles in solutions. Differences in size will result in different settling velocities and this phenomenon can be used to effect size separations.

Many solids crystallized from solution in evaporators and vacuum pans fall in the size range of 10 to 140 mesh. Perry's Handbook (3rd Ed., p. 1019) states that particles in this range (100 to 1,200 microns dia.) are covered by the "intermediate law" of settling, provided that the Reynolds number is in the range of 2.0 to 500. This law is:

$$u_t = 0.153\,\frac{g^{0.71} D_p^{1.14} (\rho_s - \rho)^{0.71}}{\rho^{0.29} \mu^{0.43}}$$

Although the formula is for spherical particles, tests by the writer show that it holds approximately for any other shape.

This formula is extremely useful, but it is expressed in metric units and contains fractional exponents which make it unwieldly to handle. The nomograph above has been expressed in English units and thus should encourage engineers to calculate rather than guess at sinking velocities.

Example—What is the sinking velocity of a 12 U. S. mesh particle of 3.03 sp. gr. in a liquor of 1.2 sp. gr. and 2.0 centipoises viscosity?

Solution—The specific gravity after buoyancy correction is 3.03 − 1.2 = 1.83. Connect 12 on Line *A* with 1.83 on Line *B*, marking Point *c* on Reference Line *C*. Connect *c* with 1.2, the specific gravity of the liquid, on Line *D*, and mark the intersection *e* with Reference Line *E*. Connect *e* with the viscosity 2.0 on Line *F* and mark Point *g* the desired sinking velocity, 0.61 ft./sec.) at the intersection with Line *G*.

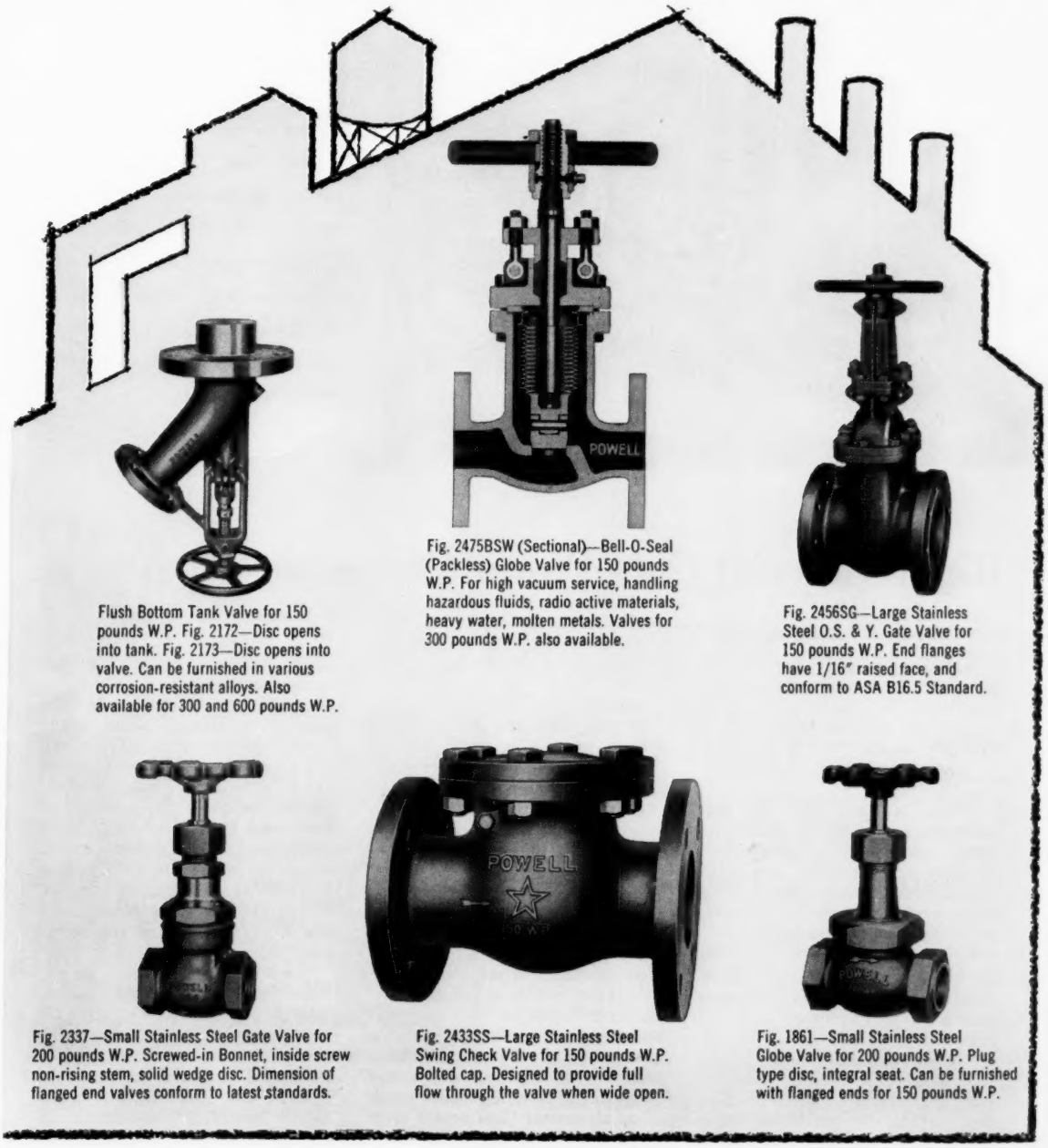
To determine whether the Reynolds number is within the range of 2.0 to 500, we can easily calculate N_{Re} from the following formula:

$$N_{Re} = 7{,}754(D_p u_t \text{ sp.gr.}/\mu)$$

where D_p is particle diameter in inches, u_t is the terminal sinking velocity, ft./sec., and μ is viscosity expressed in centipoises. The coefficient takes care of the change of units from the usual expression. In our problem draw a horizontal line from Point *A* to Scale *H*, finding D_p = 0.065 in. Substituting in the formula, $N_{Re} = 7{,}754 \times 0.065 \times 0.61 \times 1.2/2.0 = 185$, which is well within the acceptable Reynolds number range.

POWELL

world's largest family of valves



Flush Bottom Tank Valve for 150 pounds W.P. Fig. 2172—Disc opens into tank. Fig. 2173—Disc opens into valve. Can be furnished in various corrosion-resistant alloys. Also available for 300 and 600 pounds W.P.

Fig. 2475BSW (Sectional)—Bell-O-Seal (Packless) Globe Valve for 150 pounds W.P. For high vacuum service, handling hazardous fluids, radio active materials, heavy water, molten metals. Valves for 300 pounds W.P. also available.

Fig. 2456SG—Large Stainless Steel O.S. & Y. Gate Valve for 150 pounds W.P. End flanges have 1/16" raised face, and conform to ASA B16.5 Standard.

Fig. 2337—Small Stainless Steel Gate Valve for 200 pounds W.P. Screwed-in Bonnet, inside screw non-rising stem, solid wedge disc. Dimension of flanged end valves conform to latest standards.

Fig. 2433SS—Large Stainless Steel Swing Check Valve for 150 pounds W.P. Bolted cap. Designed to provide full flow through the valve when wide open.

Fig. 1861—Small Stainless Steel Globe Valve for 200 pounds W.P. Plug type disc, integral seat. Can be furnished with flanged ends for 150 pounds W.P.

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Much is now known about the causes and prevention of centrifugal pump corrosion. A big factor in prevention: choosing the optimum material of construction. Here is how to choose wisely to reduce material loss, maintenance and downtime.

Right Material Cuts Pump Corrosion

F. R. Drahos, Byron Jackson Co.*

Handling a wide variety of chemicals under difficult process conditions, it's no surprise that pumps are subject to corrosion of many types. This is a major problem in most chemical plants.

While no one has all the answers, recent developments in pump corrosion control—particularly in proper economic choice of materials—are cutting into costly material losses, maintenance and downtime.

▶What Is Corrosion? — The problem is attacked all along the line, for corrosion in pumps comes in many forms and varieties:

• Galvanic corrosion. When two dissimilar metals, such as cast iron and bronze, contact or are electrically contacted in a electrolyte, a galvanic cell forms. Current flows with the more active metal going into solution. Corrosion is usually localized near the point of contact, and may appear as deep grooves or pits. Attack will tend to concentrate on the less noble metals (such as magnesium, aluminum, zinc, or iron).

Metals that are grouped together in the galvanic series (Mg, Al) have no strong tendency to produce galvanic corrosion, and are relatively safe to use in contact with each other. The farther apart the metals stand in the series, the greater will be the galvanic tendency (Mg, Monel).

Design or economics may call for dissimilar metals to be coupled together. When coupling of dissimilar metals is unavoidable, galvanic corrosion may be minimized by (1) using insulated spacer joints, (2) cathodic protection, (3) the design practice of avoiding coupling small areas of anodic metal (less noble) with large areas of cathodic metal (more noble).

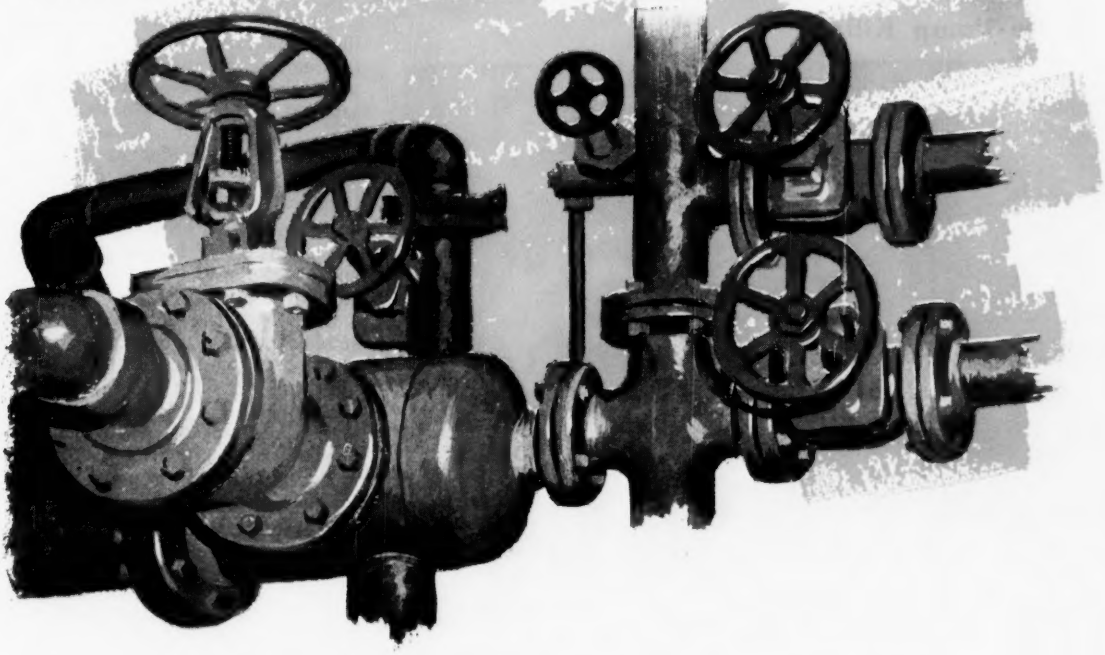
• Uniform corrosion. As the name implies, this is a uniform attack on the metal. It is generally eliminated by selecting a material more resistant to the corroding solution, or by using inhibitors, protective coatings, or combinations.

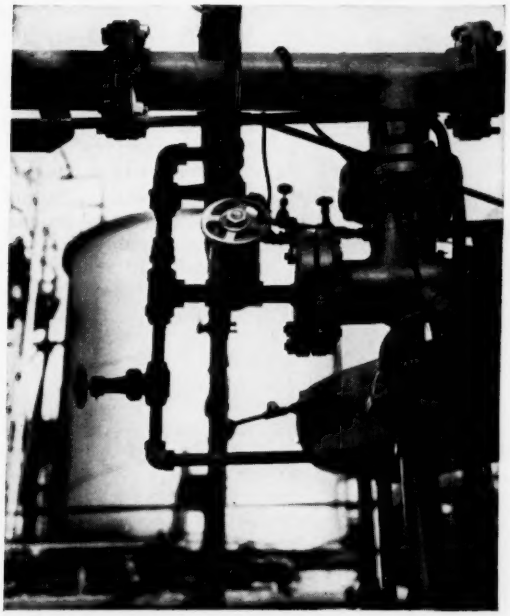
• Erosion corrosion. In this type of centrifugal pump corrosion, corrosion-resistant films or end products build up on metal surfaces attacked, but are soon washed away by the velocity of the pump fluid. Corrosion then starts anew on the fresh metal uncovered. Erosion is actually a combination of abrasion and corrosion. The 18-8 stainless steels are recommended for this service.

• Intergranular corrosion. This form of corrosion is primarily confined to the austenitic, non-magnetic chrome-nickel group of stainless steels and is evidenced by attack on the grain boundaries. The result is practically complete destruction of the mechanical properties of the metal for the depth of the attack. Intergranular corrosion can be prevented by solution-annealing vulnerable metals, or by choice of less vulnerable metals which do not precipitate carbon in grain boundaries.

* Meet your author on page 186.

HAYNES Alloys solve the *tough* corrosion problems





Valves previously used lasted only a day . . . but alloy B valves exposed to sulphuric acid and live steam while regulating flow from a neutralizer unit are expected to last indefinitely.

Refinery Corrosives Economically Controlled

Aluminum chloride, hydrogen sulphide, sulphuric acid, and other strongly corrosive media usually associated with refinery operations are handled safely and economically by equipment made of HASTELLOY alloys. Complete protection can be assured by specifying HASTELLOY alloys for use in towers, concentrator tubes, heat exchangers, tubing, pipe, pumps, and valves.

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Three Pump Killers

EROSION CORROSION can be controlled with 18-8 stainless steels.

PITTING CORROSION calls for a metal which will stand up to halogens.

CAVITATION CORROSION: poor design with improper velocities.

• Pitting corrosion. This takes the form of localized attack in which rapid penetration may take place at several small areas of random location. In general, pitting is most likely to occur when chlorides or other halogens are present in oxidizing solutions.

• Cavitation erosion. An additional form of trouble experienced is cavitation erosion, basically a dynamic action within a fluid, with the formation and sudden collapse of vapor-filled cavities by sudden changes in pressure.

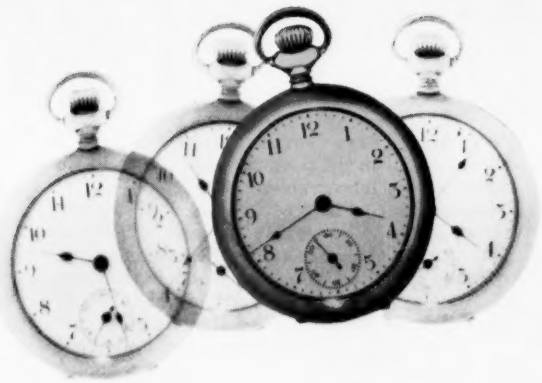
Symptoms of cavitation erosion is a sharp granular outline, similar to heavy shot blasting, and freedom from corrosion products. In centrifugal pumps, the suction side of the pump impeller will be most susceptible to this type of attack.

The best remedy for damage by cavitation is through design of the pump with proper velocity distribution and adequate residual pressures, to eliminate cavitation conditions. Cast 18-8 stainless, aluminum bronze and 13% chromium are used successfully; overlays of 17-7 Cr-Ni, 18-8 Cr-Ni and aluminum bronze have given satisfactory results when used on steel base metal.

► **Material Economics** — Manufacturers of centrifugal pumps, due to complex pump designs, generally prefer to rely on the proper choice of materials used for prevention of corrosion, rather than on protective coatings, linings, etc.

There are many cases in the chemical and allied industries where coatings and linings must be resorted to, from an economics standpoint. Tanks, vats, and large pipes, for example, with large areas to be protected, would be far too expensive if the designer had to rely on metallurgy alone for corrosion prevention.

In such cases linings and coatings, easily applied on large regular surfaces, prove very practical. But in the case of centrifugal pumps, with relatively small, irregular, intricate surface areas coming in contact with corroding fluids, use of more expensive corrosion-resisting materials is frequently justified, on the basis of long-



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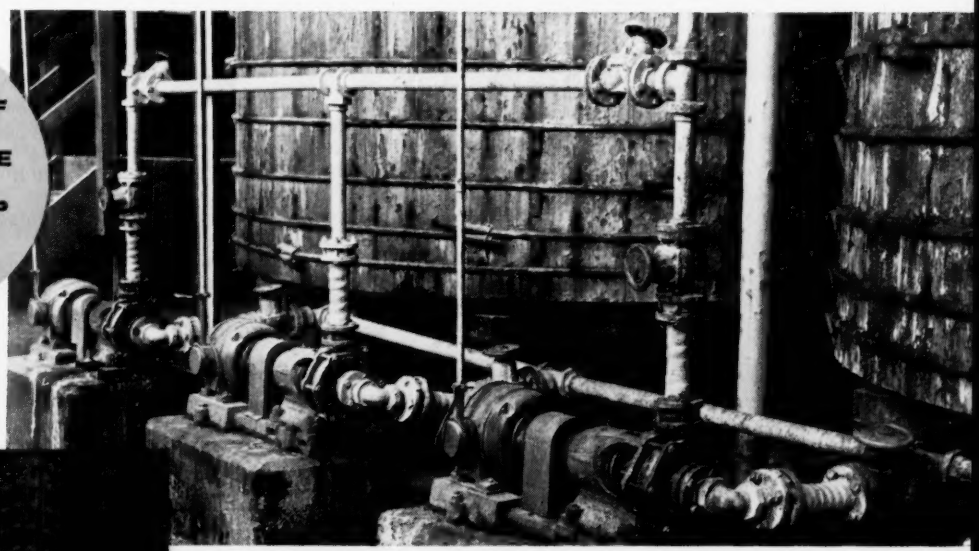
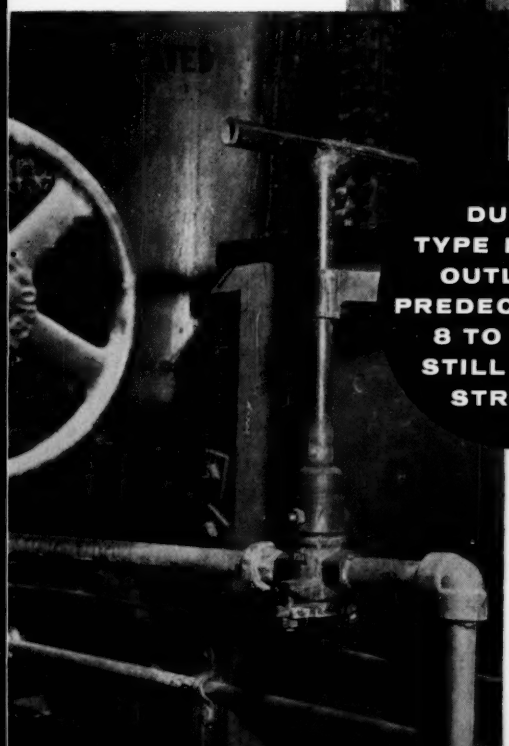




DURCO TYPE F VALVE OUTLASTS PREDECESSORS 8 TO 1 AND STILL GOING STRONG!

Time has proved to American Synthetic Rubber Corporation that no pumps outlast DURCOPUMPS in corrosive service. These DURCOPUMPS, in service since 1943, operate twenty-four hours a day, seven days a week handling sulfuric acid and brine at 140° F. ASRC is contemplating purchasing some new DURCOPUMPS to replace those of another manufacture that failed in a similar service.

Durco Type F valves have also proved to be the answer on a concentrated sulfuric acid line. Where other valves usually froze or failed in less than two weeks, the Durco Type F valve has been in service for five months without even requiring adjustment. Now ASRC is replacing a number of other valves on this line with Durco Type F valves with renewable Teflon sleeve.

DURCO *the mark of dependability in tough chemical service . . . everywhere*

The Duriron Company, Inc.

DAYTON, OHIO

time trouble-free service. Nevertheless, pumps lined with plastics and glass are available for special applications.

From the economics standpoint, many factors are involved in the choice of metallurgy. Some of these are (1) initial cost of the material used, (2) workability of this material and consequent machining and fabricating costs, (3) life expectancy of the material in a given environment, (4) cost of plant shut-downs for replacement of units, (5) safety considerations, (6) financial situation of the purchaser.

As a rule, materials should be specified which are available at reasonable cost, even though corrosion resistance could be more complete with more expensive materials.

For example, tantalum, Hastelloy or other high alloys are extremely good materials from a corrosion standpoint, but are usually too expensive for the average application. Limited finances may prevent use of optimum metallurgy, making it necessary to resort to a less expensive material in which some corrosion may be expected. In many cases, the pump manufacturer will recommend a higher cost material than the customer had intended to use because of the long trouble-free service such a material brings with it.

Also, if the chemicals processed are very valuable and can be contaminated by products of corrosion, or if dangerous compounds might be released to the atmosphere, use of such high-cost materials is definitely justified.

▶**Common Pump Materials** — Cast iron, cast steel, and wrought steel are three of the lower cost materials most frequently used in conventional pump construction. These have a reasonable degree of corrosion resistance for many applications.

Carbon steels furnish by far the greatest tonnage used for centrifugal pumps for non-corrosive service up to 700 F. They are readily available, easily workable, and in many cases have a reasonable degree of corrosion resistance.

Another group of commonly used materials consists of the brasses and bronzes. These are generally used in applications where a high degree of corrosion resistance is desired, particularly where mineral salts are present or a large amount of aeration exists in waters being pumped.

There is one drawback in specifying brasses and bronzes: many are not available in wrought forms. Practically all are available as castings, and as such find wide application.

Chrome irons and steels (11 to 13% chrome) find extensive usage in both the refinery and the power industries. In refineries they have high corrosion resistance to sweet crudes, sour crudes, and to fluids present in high-temperature cracking operations. The power industry finds this group of materials particularly useful because of resistance to corrosion from boiler feed waters and condensate waters—two liquids normally corrosive to carbon steels and to iron under velocity conditions.

The chrome steels and irons are about seven times more expensive than carbon steels and cast iron, but are stronger, readily workable, and are available in wrought forms, and as castings and forgings.

▶**Stainless Steels for Pumps**— Another family of materials widely used for centrifugal pumps are the chrome-nickel-stainless steels (18 Cr-8Ni). These have a very low corrosion rate for most applications. Refineries, the food industry, and mining operations frequently specify centrifugal pumps of this group of materials.

Chrome-nickel stainless steels are higher in cost than the metals previously discussed, and are available as castings, forgings, and plate. They owe their low corrosion rate to the combination of chrome to nickel, and the low amount of carbon present. The fact that they are high in alloy and more difficult to machine contributes to high cost finished units.

The corrosion resistance of chrome-nickel stainless steels is greatly impaired if they are not given proper heat treatment. With improper heat treatment, carbon precipitates out of the grain and into the grain boundary. Corrosion then takes place in the boundary and the result is intergranular corrosion.

For specific applications, other more highly alloyed forms of nickel-based materials may be used where an even higher degree of corrosion resistance is required. The Hastelloys represent one of these groups. In many cases such materials are more difficult to machine, require more hours of fabrication time, and consequently increase the cost of the finished products. However, they are frequently the most economical to use because they give long, trouble-free service.

Big Advances in Ultrasonic Welding

Ultrasonic welding has come a long way. Not long ago only 0.010-in. aluminum could be joined. Now ultrasonic welds of good strength can be produced in 1100 aluminum 0.070-in. thick, and 0.060-in. Alclad structural alloys are joined with high bond strengths.

Mr. J. B. Jones of Aeroprojects, Inc., West Chester, Pa., at a Washington, D. C., joint meeting of the American Society for Metals and the American Welding Society, revealed these details in reporting on the latest developments in ultrasonic welding of high-temperature and corrosion-resistant materials.

The exotic metals — molybdenum, niobium, tantalum, zirconium, titanium, Inconel, Inconel X, and 17-7 precipitation hardening steels have all been joined by ultrasonic welding in sheet gages up to about 0.030 in.

There is a high degree of internal deformation of metal at the joint of an ultrasonic weld, but little external deformation.

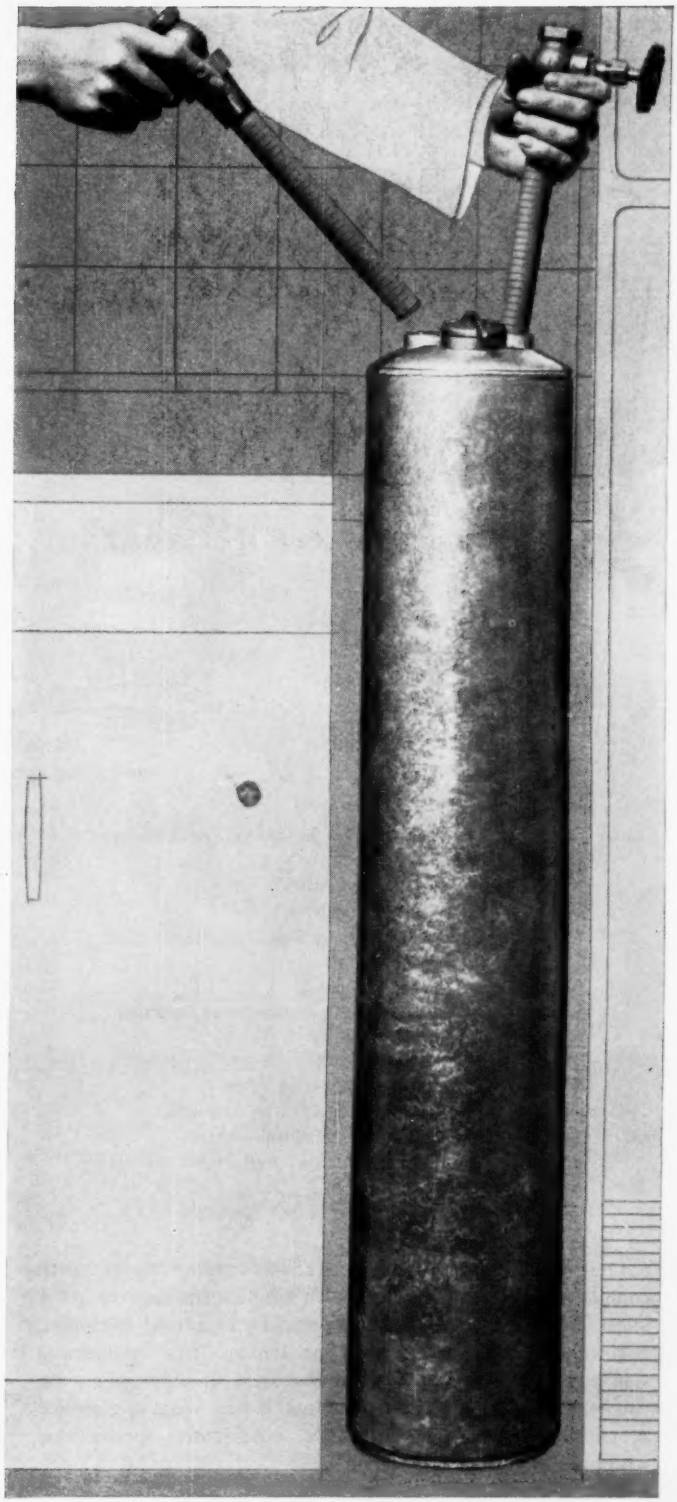
In bimetallic joints, there is no formation of brittle intermetallic or metallurgical mixtures of unknown corrosion characteristics. This is one big advantage of ultrasonic welding.

Still in the development stage, the new welding technique consists of clamping pieces to be joined between two sonotrodes and introducing ultrasonic vibratory energy through an electronic circuit. Result is a solid-state metallurgical bond.

USCOLITE PIPE

MR. USCO REPORTS:

THE PIPING that never needs replacement



To handle the highly corrosive brine used in regenerating this Cesco Water Softener, two lengths of Uscolite thermoplastic pipe are used. Uscolite is so highly resistant to the brine that *not one section of it has ever had to be replaced!* And there's no possibility of electrolysis due to the use of dissimilar metals. In fact, Uscolite® Pipe remains in such perfect condition that when the water softener tanks require replacement, the pipes are removed and used in new units.

Uscolite thermoplastic pipe is a product of United States Rubber. It is highly resistant to most chemicals, is extremely light, yet has very high impact strength. It just never seems to deteriorate.

A complete line of pipe and fittings (including unique UscoWeld* solvent-weld fittings)—plus the assistance of trained sales engineers who *know plastics*—is available at selected "U.S." Distributors, at any "U.S." branch, or contact us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

National Sanitation Foundation Seal awarded to Uscolite Pipe

*Patent applied for.

Mechanical Goods Division

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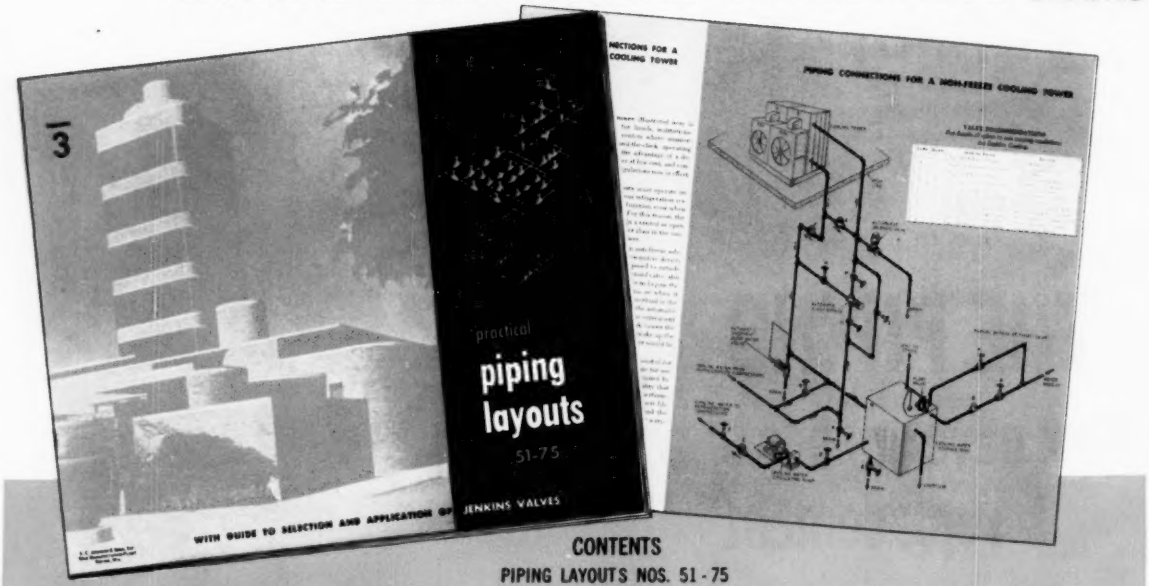

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PLUS 10 PAGES OF VALVE SPECIFICATIONS

Volume 3 is a 36-page collection of 25 basic piping diagrams with complete recommendations for valve selection and location in the lines. The material has been prepared by registered consulting engineers in collaboration with the Jenkins Bros. engineering staff and leading equipment manufacturers. It supplements the two booklets released by Jenkins Bros. in past years as a service to consulting engineers, architects, contractors, specification writers and plant operation managers.

In addition to the piping diagrams, this book contains a ten-page, illustrated quick-reference specification "chart" which gives essential data on the complete line of Jenkins Valves.

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Chemical Engineering

People

MARCH 10, 1958

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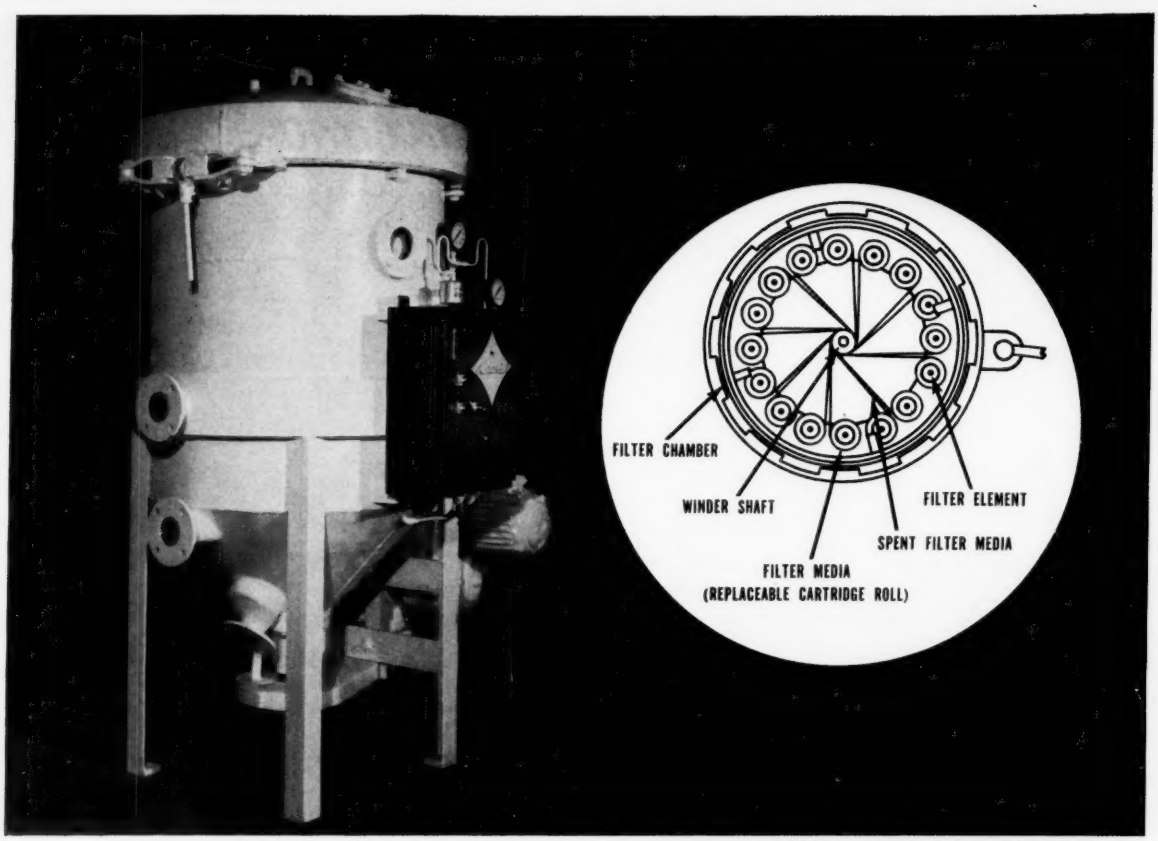

NEW! Cyclamatic "Type 117" Filter automatically changes filter media

. . . unit is ideally suited for low solids, high clarity operations

Industrial's new Cyclamatic "type 117" continuous pressure filter consists of a series of vertical tubes arranged in a circular pattern which fit into a common manifold located around the periphery of the vertical chamber. **Each tube consists of a central core** with non-woven fabric or paper wound around it leading to a central winder spool . . . **these multiple layers of filter media achieve sub-micron filtration** with extremely low pressure drop. In addition to this, the rolls can also be supplied with a **central core of diatomaceous earth, carbon** or others, including **desiccant material for jet fuels** . . . this is an **exclusive design with Industrial.** Frequent and **costly interruptions in production are eliminated** due to the **automatic changing of filter media** activated by a predetermined pressure drop across the filter. When this occurs the **central winder simply winds off the contaminated top-most layer of paper** and **exposes a new uncontaminated layer.**

This **new filter by Industrial** is absolutely fool-proof and can be **extremely useful in filtration** of jet fuels, cutting oils, shipping oils, paint wastes, effluent liquors containing radioactive particles, long cycle trap and polishing jobs, such as polishing beer, process waters and the like. Total filter areas range from 400 square feet to 7,500 square feet with filter diameters from 14 to 48 inches and can be equipped with or without a quick opening cover.

For complete details and specifications write for BULLETIN 117.

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What Makes a Successful Chemical Engineer

Richard S. Schultz, President, Industrial Relations Methods, Inc., New York*

What qualities do you look for in a young chemical engineer? What are the characteristics that can be used to predict and measure possible success in the profession?

Based on more than 20 years' experience in the field of selecting, testing and appraising chemical engineering graduates in industry and in the academic environment, we believe that we have some answers to these questions. We present our answers as a possible aid to both management and individual employees in the chemical process industries.

What Goes Into Success?

Speaking broadly, success in a career or profession has been portrayed as being influenced by a combination of these three major factors:

- Ability.
- Motivation.
- Personality.

When an individual has his sights (motivation) set in keeping with his ability and has a favorable opportunity to allow his individuality (personality) to mature with age and experience, then he may be said to be successful.

For practical purposes it has been estimated that ability accounts for about 50% of the factors contributing to success in a particular occupation. Motivation, interests, personality and willingness to work contribute another 35% to success. The remaining 15% are fortuitous or chance factors.

Chance may play an important part in terms of whether the profession is expanding, the kind of organization in which the individual is employed, the types of bosses, home conditions and a multiplicity of other circumstances or factors identified with daily living and earning a livelihood.

With this as a basic pattern for success, we've used a battery of tests that helps measure essential qualifications.

17 Factors to Consider

We have found 17 qualities to be essential for success in the chemical industry; but some special attributes may be more desirable than others in accordance with particular company operations and distinct position or career opportunities.

These are the three primary or differentiating qualifications usually characteristic of the most promising young chemical engineers:

- Objectivity. This is a combination of attitude, personality traits and mode of thinking, wherein the young man tends to rely more on facts and reasoning than on personal opinion or preference. He is alert to ideas and suggestions of others. He seeks logical, alternative or best answers to a problem, answers which are realistic and sound.
- Scientific thinking. This is an attribute which he will have acquired by virtue of his technical and scientific training. It is a well-defined method, procedure or series of steps learned in his various courses. It is a capacity which he possesses and uses beginning with his first job after college. He continually makes use of the scientific mode of thinking in daily problems and responsibility on the job.
- Special aptitudes. Statistical data on young men who do well in chemical and engineering courses and continue successfully in industrial careers reveal that among their outstanding qualifications are above average or higher ratings in general intelligence, mathematics, physical-chemical sciences and visualization.

These Are Important Too

The following list of supplementary attributes further portrays the profile of the preferred young chemical engineer:

Accomplishment—He is likely to have a meritorious college record of accomplishment in his courses, part-time work and extra-curricular activity.

Desire for Growth—Young men who tend to make progress

* Meet your author on p. 181.

How You Rate on Tests for Ability

General Intelligence Scores in the Chemical Industry

Rating	Chemical Engineers %	Chemists %	Mechanical Engineers %	Miscel. Technical & Science B. S. %	All Men %
Good	75.3	62.9	52.8	48.5	65.1
Medium	14.0	25.3	34.5	33.8	22.7
Low	10.7	11.8	12.7	17.7	12.2
Totals	100.0	100.0	100.0	100.0	100.0
Number of men	215	178	55	68	516

OBSERVATION—Employees in the chemical industry with chemical engineering degrees rate predominantly "good" in general intelligence and consistently higher than men with other technical or scientific education.

Here's How Ratings on Technical Intelligence Compare

Rating	Chemical Engineers %	Chemists %	Mechanical Engineers %	Miscel Technical & Science B. S. %	All Men %
Good	32.1	18.8	22.4	17.0	24.6
Medium	51.4	47.1	63.3	35.6	49.2
Low	16.5	34.1	14.3	47.4	26.2
Totals	100.0	100.0	100.0	100.0	100.0
Number of men	212	176	49	59	496

OBSERVATION—Employees in the chemical industry with chemical engineering degrees tend to rate generally higher in technical intelligence than men with other types of scientific or technical education.

How You Rate on Tests for Motivation

Economic Motivation

	% Good., Med., Low
Ch. E.	53.1, 39.9, 7.0
Chem.	55.8, 36.6, 7.6
M. E.	55.1, 40.8, 4.1
Misc.	63.5, 31.7, 4.8
All	55.5, 37.8, 6.7

Technical Motivation

	% Good, Med., Low
Ch. E.	46.5, 49.3, 4.2
Chem.	47.1, 50.6, 2.3
M. E.	36.7, 59.2, 4.1
Misc.	50.8, 41.3, 7.9
All	46.3, 49.7, 4.0

Social Motivation

	% Good, Med., Low
Ch. E.	13.1, 58.7, 28.2
Chem.	16.3, 61.6, 22.1
M. E.	16.3, 65.3, 18.4
Misc.	12.7, 57.1, 30.2
All	14.5, 60.1, 25.4

Leadership Motivation

	% Good, Med., Low
Ch. E.	38.5, 53.0, 8.5
Chem.	38.4, 48.8, 12.8
M. E.	34.7, 57.1, 8.2
Misc.	44.5, 47.6, 7.9
All	38.8, 51.3, 9.9

Cultural Motivation

	% Good, Med., Low
Ch. E.	3.3, 29.6, 67.1
Chem.	4.6, 23.3, 72.1
M. E.	2.0, 34.7, 63.3
Misc.	1.6, 15.9, 82.5
All	3.4, 26.2, 70.4

Spiritual Motivation

	% Good, Med., Low
Ch. E.	23.0, 43.7, 33.3
Chem.	22.1, 37.2, 40.7
M. E.	20.4, 38.8, 40.8
Misc.	23.8, 41.3, 34.9
All	22.5, 40.6, 36.9

OBSERVATION—Employees in the chemical industry rate generally good in economic motivation; mostly good or medium in technical motivation; not so good in social motivation; medium in leadership; low in cultural motivation; and predominantly low or medium in spiritual motivation.
NOTE—Horizontal line total is 100% for each group.

in their careers, have strong motivation for improving and growing. They do not stop learning because they have obtained a technical or engineering degree.

Clarity of Career Objectives—He is eager for an opportunity to use his education and abilities. He has a professional attitude towards his career. He seeks opportunities for experience and training in accordance with his immediate long-term ambitions. He is most interested in establishing his value to the company in job assignments. In essence, his career objectives are directed towards demonstrating ability rather than obtaining immediate primary monetary rewards.

Special Knowledge and Skills—He has acquired special knowledge and skills by virtue of his college training and experience which makes him attractive to a company considering him for employment. He will have such distinct and tangible abilities that it's easy for a company to immediately evaluate his desirability for initial job assignments and development.

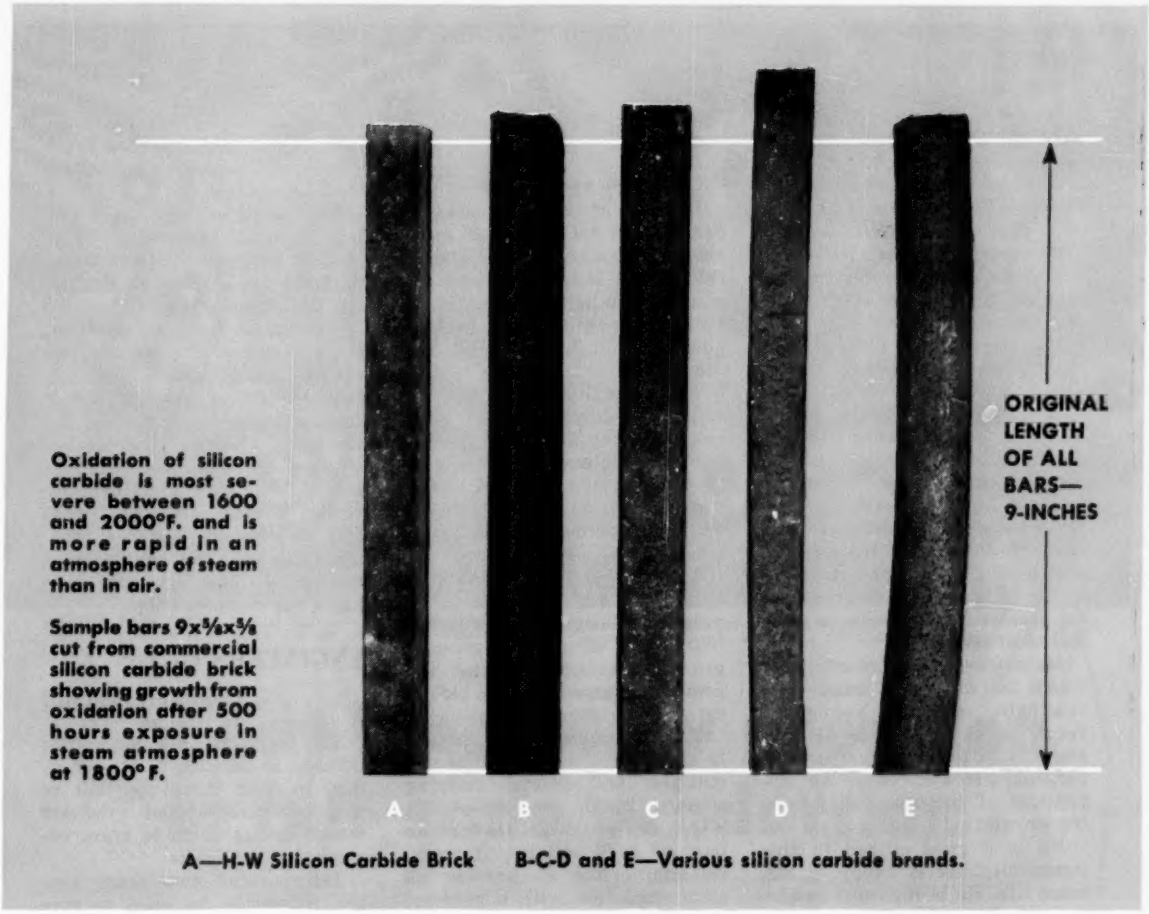
Adaptability—He reveals flexibility in his thinking, work performance and personality. This enables him to keep in stride with industrial-technical progress and to grow professionally in the broadest sense.

Communications Skill—He will have adequate skill in writing and speaking so that he builds confidence in his role as a technical specialist.

Curiosity—He shows wide interests with an unquenchable and "purposefully controlled" curiosity for diverse problems, situations and ideas pertinent to a particular field and other technology or engineering subjects. (This is a characteristic of the superior mind, whether in reference to technical work, creative accomplishment or future administrative capacity.)

Personal Adjustment—He appears well-balanced, emotionally stable and self-confident. Too many young technical graduates are lacking in this respect, not because they are in their late adolescence, but more so on account of not having their goals and objectives clearly focused.

Avocational Interests and Activities—He has a wide breadth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of interests in technical and non-technical fields. He engages in hobbies, recreational activities and community affairs with considerable enthusiasm and success. It is such utilization of his talents and energies which enables him to further develop his personality and to succeed with a particular company.

Receptivity to Constructive Criticism—He responds favorably to constructive suggestion. It is also a characteristic which makes a young technical man a desirable employee. It's an essential part of the process of learning and developing which takes place after college graduation. That makes it more likely that he will grow and develop as a chemical engineer, and possibly for greater responsibility in non-technical activity.

Maturity—This is an attribute which he will show quite convincingly, although young in years. His motivation, desires, and outlook towards a career and personal life will convey an impression of balance and of having grown up.

He is a good citizen in the community. He is happy in his home life. He is regarded as the more desirable type of employee in his company. He is interested in what is going on in his industry and his community.

He is likely to be alert to furthering his education and cultural background, in areas to which he may not have been exposed during college.

Responsibility—He shows dependability and consistency in fulfilling obligations. He takes his job, duties as a citizen and home life seriously. He has a high sense of self-respect and conducts himself in a manner deserving of favorable comment. He has a constructive outlook towards maintaining good physical and mental health.

Character — He establishes clearly his integrity, honesty, and ethical conduct. He fulfills this qualification in combination with satisfactory maturity and a marked sense of personal responsibility.

Habits—He is meticulous in his habits of work, personal conduct and relations with people. This qualification facilitates personal growth and development in his career with a particular company.

For Selection and Development

In view of current increased demand for technical and engineering personnel in the chemical process industries—and the emphasis on better utilization of such manpower—the checklist above should have special significance.

These qualifications can be helpful in development of present personnel in a company. For selection, placement and training of new employees, the 17 points may serve as a distinct guide not only to personnel officers but to supervisors and executives.

There is also a possibility of applying such information in programs designed to encourage individual effort in personal growth, development and improvement among young technical and engineering employees.

The list of qualifications may be used effectively in initial orientation and special training courses within companies for young technical graduates. As part of such activity, it would be appropriate to provide all such employees with a personal copy of this checklist.

Applies to Almost All

Although these 17 factors for success apply to the young chemical engineer in particular, they should also be significant for other young technical graduates employed in the chemical process industries. It is with this thought in mind that we close by calling your attention to the two tables of characteristic test results reproduced on p. 172.

COFFEE BREAKS

. . . *Break Into News*

The National Labor Relations Board has now ruled that it is an unfair labor practice for a company to end a "coffee break privilege" without consulting its workers' union.

The board ordered the Fleming Manufacturing Co., Cuba, Mo., to bargain with the International Association of Machinists on coffee breaks.

In another unusual decision, the Workmen's Compensation Court in Elizabeth, N. J., awarded an employee $1,050 in compensation for a foot injury sustained while playing softball on company time. The court held that, because the injury occurred during a "coffee break" and because the employer supplied the bats and balls used in the game, the employer was liable for compensation.

ENGINEERS GET

. . . *a Graduate School*

The College of Advanced Science, in Canaan, N. H., scheduled to open this July, will be the first independent graduate school in the U. S. to train engineering scientists.

Incorporated two years ago, the college is designed to give two years of intensive physical science teaching to engineers with B. S. degrees. The curriculum—based on a concept of teaching theoretical physics at the maximum rate—leads to an M. S. degree.

HOW TO

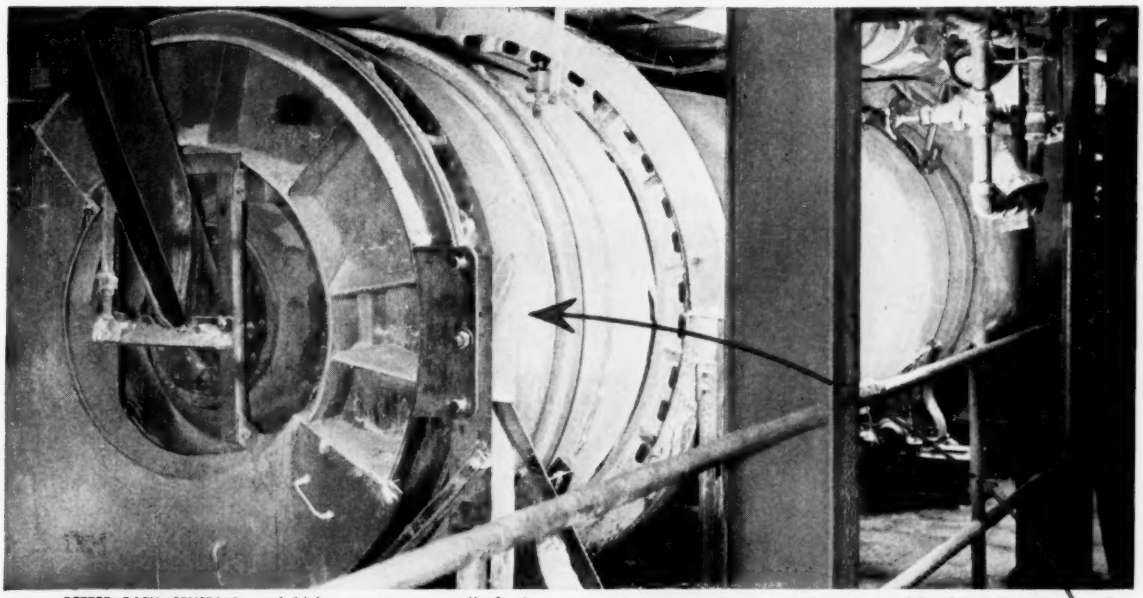
. . . *Make a Speech*

Effectiveness of a manager varies directly with his ability to secure understanding and acceptance by other people.

This thought will be the theme for a new course scheduled to start on March 17 at the American Management Assn. Academy, Saranac Lake, N. Y.

Coming: Let's Look at the Shortage One More Time

Once again the barrage of statistics on supply and demand of engineers is rolling into print. Everyone is an expert. No two experts seem to agree. It's time, we think, to take an engineering look at the problem of how many engineers there really are; how many there will be; and, most important of all, what information is still lacking in all the expert guesstimates.



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Repeat laboratory precision in full-scale production

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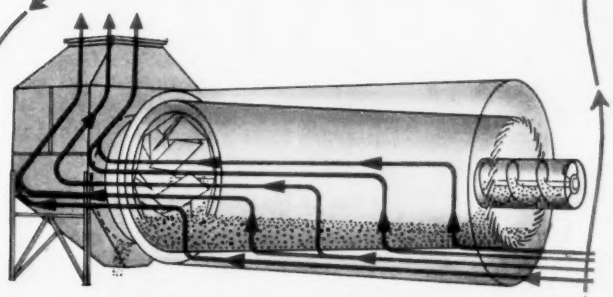
YES, it's easy to duplicate the quality of laboratory test samples on production runs using a Link-Belt Roto-Louvre dryer. Accurate "scale-up" is readily achieved because of Roto-Louvre's unique design and precisely controlled drying.

Compact and highly effective, this machine introduces dry, heated air through ever-changing channels, exposing the entire surface of every particle to uniform treatment. For facts, send for Book 2511. Or, if you prefer, send a sample of your material and we'll work out drying, cooling or roasting procedures you can duplicate in your own plant.



Common-sense design assures effective heat transfer

Roto-Louvre has largest volume of air penetrating thin bed of material near feed end, where greatest evaporation must take place. As material moves forward and bed becomes thicker, smaller air passages reduce volume of air passing through bed, preventing overheating. Precise control of input air temperature, exhaust and conditions of material travel assures maximum heat transfer per cubic foot of air.

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PEOPLE . . .

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ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY. FIRST SUPPLEMENT. Edited by R. E. Kirk and D. F. Othmer. Anthony Standen, Assistant Editor. Interscience Encyclopedia, New York. 974 pages. $25.

It's more than 10 years since the first volume of your Encyclopedia of Chemical Technology appeared. And it's about two years since the set was completed by Vol. 15.

Our technology never stands still. It's been said that a book is out of date by the time it's published. So, in order to keep their Encyclopedia nearer-to-date the editors offer you their First Supplement Volume.

It's not concerned with basics which were adequately covered and have changed but little. It extends of course, and adds to ECT by meticulous attention to subjects that today are more important than they were yesterday. Computers, for example. And the dyeing of synthetic fibers, emulsion paints, fluidization, nuclear reactors, solar converters, steroids, tranquilizers, water demineralization.

The list comprises 51 articles and their caliber is even higher than those in ECT itself. The 72 authors have done outstanding jobs. Be sure to check this volume, too, whenever you are looking to ECT for help.—LBP

Fundamental Reference

COMPLEXOMETRIC TITRATIONS. By Gerold Schwarzenbach. Translated and revised by the author and Harry Irving. Interscience Publishers, Inc., New York. 132 pages. $3.75.

Reviewed by J. Westheimer.

Workers in the chemical profession who are familiar with the tremendous usefulness of complexometric titrations in chemical analysis will surely welcome this translation of Dr. Schwarzenbach's important treatise on the subject.

The book is divided into six chapters, progressing in logical sequence from basic theory of complexometric titrations and discussion of suitable titrants, indicators, standard solutions, to detailed description of procedures for individual metal cations. Symbolism introduced at the beginning of the work and continued throughout the text has been firmly established in the literature on the subject. This will clear up confusion among those who have not had access to the German edition.

New developments appear every day in the chemical literature, particularly with respect to new indicators, masking agents and chelating agents. Since this is a revision as well as a translation of the original book, more information on later developments might have been included. But this minor limitation is partially offset by an extensive list of supplementary references.

The book is a thorough introduction to the field of complexometric analysis and will remain a fundamental reference work on the subject.

Succinct and Rangy

CHEMISTRY OF HETEROCYCLIC COMPOUNDS. Vol. 11 — PHENAZINES. By G. A. Swan and D. G. I. Felton. Interscience Publishers, New York. 693 pages. Subscription price, $21; single price, $22.50.

Reviewed by E. A. Steck.

This treatise has resulted from blending the efforts of one scholar in the academic sphere with those of another in industry. Such a team has produced a neatly balanced assembly of material, richly annotated.

The introductory discussions on synthetic methods are succinct, and the range of applications and variants is the more

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remarkable through free use of complete structures and tabulations. Swan was responsible for the first 209 pages on non-condensed phenazines, and Felton the 402 pages on condensed phenazine types, each with respectable addenda so that the entire work covers important literature to late 1956.

Each aspect has been handled with admirable completeness. Cross-references, uniformity of nomenclature, ring index classifications of structures, colour index references to dyestuffs, important spectral data, and uses have all been blended carefully. Further, the highly significant aspects of phenazine dyes are clearly treated, with patent citations and references to *Chemical Abstracts*, *Chemische Zentralblatt* or Friedlaender.

This is a valuable addition to the series of monographs for which Weissberger has acted as consulting editor, and should long remain a useful source of information on phenazines.

BRIEFLY NOTED

AMERICAN STANDARD STEEL PIPE FLANGES. *76 pp. Order Department, American Society of Mechanical Engineers, 29 W. 39 St., New York 18, N. Y. $3.* Covers ratings, designations, tolerances and tests pertaining chiefly to cast and forged-steel flanges.

PERSPECTIVE OF MOLYBDENUM-BASE ALLOYS. *By Alvin J. Herzig. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $1.50.* Lecture given at 60th annual ASTM meeting, June, 1957, gives technical information on molybdenum-base alloys.

More New Books

PLANT DESIGN AND ECONOMICS FOR CHEMICAL ENGINEERS. By Max. S. Peters. McGraw-Hill. $11.

MANAGEMENT FOR ENGINEERS. By Roger C. Heimer. McGraw-Hill. $6.75

FILM FORMATION, FILM PROPERTIES AND FILM DETERIORATION. Edited by Charles R. Bragdon. Interscience. $9.75.

MAN-MADE FIBERS, 3rd ed. By R. W. Moncrieff. Wiley. $9.75.

PEOPLE...

MEET YOUR AUTHORS

M. A. GIBBONS

R. E. Githens, Jr.

LET COMPUTERS PICK YOUR EXCHANGERS. PAGE 143.

During the past few years, Author Githens has done quite a bit of experimenting with programs for rating heat exchangers on a large scale digital computer. He believes it can be done this way—economically: "Many thousands of heat exchangers are rated yearly and even small savings in unit costs can result in substantial cost reduction."

Author R. E. Githens is a senior service engineer for Du Pont. The past five years with the Wilmington firm's engineering department have given him wide experience in the fields of heat transfer and fluid flow; he serves the design division and industrial departments in these fields.

Before joining Du Pont, Githens spent six years with the Aircraft Nuclear Propulsion Project (staffed by Fairchild Engine Airplane Corp. and General Electric). Work on the project involved heat transfer and applied physics, pertaining to power reactors. It also comprised a study of some of the effects of pile radiations on physical properties of materials.

During World War II, Githens served, for three years, as a 1st Lieutenant in the Army's Sanitary Corps. There, he was engaged in water supply, sewage disposal, insect and rodent control work for Northern Luzon. He was the CO of the Malaria Survey and Control Teams.

Githens studied chemical engineering at Drexel Institute of Technology. He earned his B. S. degree there in 1943. He is active in the AIChE and a licensed professional engineer in the State of Ohio.

J. A. Lundquist

VERTICAL PUMPS. PAGE 139.

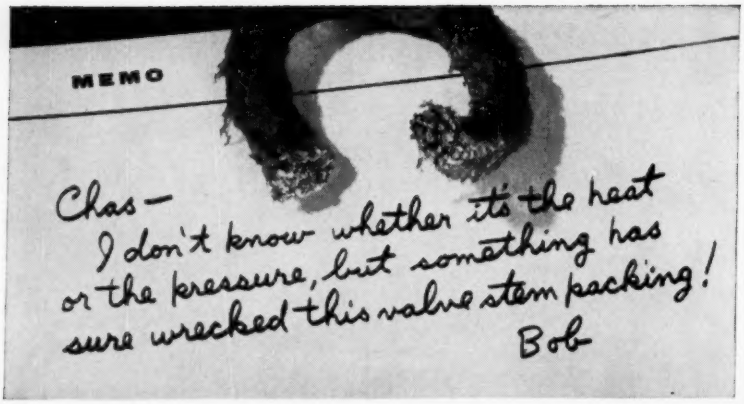
Presently, J. A. Lundquist is Philadelphia branch manager for Pacific Pumps, Inc. (one of the Dresser Industries).

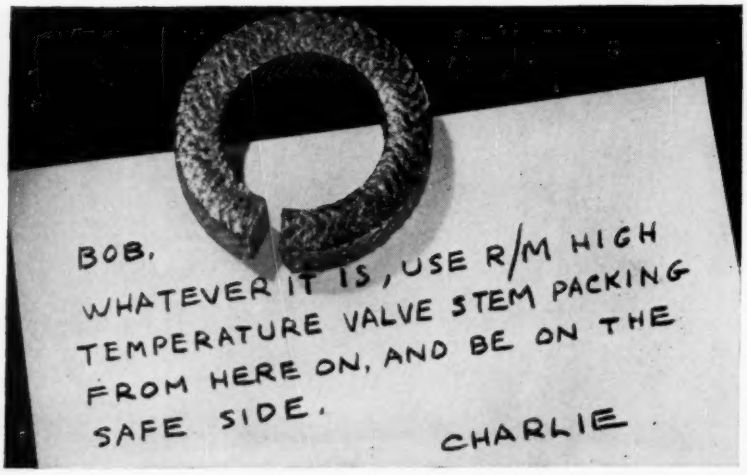
His interest in contributing to the current article grew from a realization that there was a real need to share data on hand with other engineers—so frequent were the calls at his Philadelphia desk from engineers in competitive and allied firms for advice on vertical pump applications.

Lundquist's own specific background for his work in vertical pump applications comes from working some three years in hydraulics for Walter Kidde Co. and twelve years as pump specialist-application engineer for American Cyanamid's Bound Brook plant utilizing 2300+ pumps.

Lundquist is a registered engineer in the State of Pennsylvania. He is a member of the American Society of Corrosion Engineers and active on the commissioners staff of the Boy Scouts of America.

Educational background was gleaned at Upsala College and at Brooklyn Poly. He also did grad-





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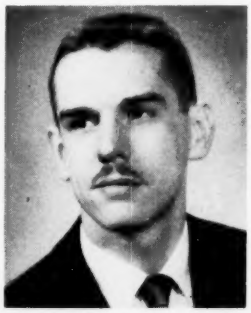
AUTHORS . . .

uate work in fluid dynamics at Rutgers.

Hobbies include hunting, fishing, and growing closer to his two sons: Arthur, 18, a high school senior, (who is an all-county football player, wrestler and trackman), and Eric, 15, a born farmer, fisherman and naturalist.



Ferdinand Rodriguez

NOMOGRAPH FINDS CONDENSATE FILM TEMPERATURES. PAGE 150.

Since 1956, Ferdinand Rodriguez has been doing graduate work at Cornell's school of chemical and metallurgical engineering, in the field of polymers. At the Ithaca school, he is an Eastman Kodak fellow.

Before getting his graduate work underway, Rodriguez spent two years in the Army as a safety engineer at Fort Detrick, Md. He worked his way "up through the ranks," he reports, "starting as private and being discharged as private first class!"

From 1950 until 1954, he served as development engineer for the Ferro Chemical Corp., in Bedford, Ohio. There, he worked on Signal Corps Research (in photosensitive plastics), on Napalm production and on other metallic soap applications.

Rodriguez earned a B. S. in chemical engineering from Case Institute of Technology in 1950. Four years later, he completed night school work on his master's, in the same field.

Besides his regular work, Rodriguez is also the author of a number of nomographs which have appeared in *Chemical Engineering* and in *I&EC*.

Hobbies center around musical

instruments—a clarinet, a saxaphone and a guitar. In the past, he has even played professionally for various dance bands.

Richard S. Schultz

WHAT MAKES A SUCCESSFUL CHEMICAL ENGINEER. PAGE 171.

Author Richard S. Schultz is president of Industrial Relations Methods, Inc., New York, a professional consulting and research service which helps business and industry to design, install and simplify methods and procedures for management of people.

For more than 25 years, he has served as a management and personnel consultant to varied business and industrial organizations. His specialized research and professional work for the chemical industries has included appraisal and aptitude test techniques for selection of employees and technical, supervisory, executive personnel.

After earning a Ph. D. at the University of Pennsylvania, Schultz joined the staff of NYU's Graduate School of Engineering where he still teaches as an adjunct professor. His record also lists a term as consulting editor of Supervision magazine; a directory mention in "Who's Who in the East," "Who Knows What," and "American Men of Science."

Schultz holds membership in the American Psychological Association, the American Management Association, and the Industrial Relations Research Association.

Among his many published works, Schultz has to his credit "You Can Make Success Your

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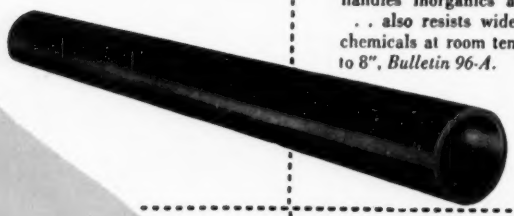

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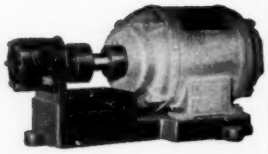

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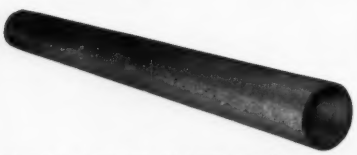

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James P. Cannon

VERTICAL PUMPS. PAGE 139.

Every time James Cannon got talking to engineers about vertical volute pumps, he found that they were either full of praise or downright livid on the subject. Such an extreme difference of opinion was obviously well worth exploring—in print.

For collaboration, he called on Art Lundquist who, at the time, was a pump specialist for American Cyanamid and the most confirmed user of vertical pumps he knew.

Cannon, himself, has had his own office, for the last five years, as an agent representing manufacturers of pumps, filters, and ion exchangers in the New York area.

Before getting into business for himself, he worked as sales representative for The Eimco Corp., manufacturers of vacuum filters and other mining machinery, for about two years. He also worked as estimator and sales engineer in Worthington Corp.'s New York district office, for the four years following his discharge from the Army.

Military service included a good deal of time aboard Army dredges, salvage ships and floating power plants. He was a 1st Lt. in the Corps of Engineers.

Cannon is a graduate of Washington State College, where he earned a B. S. in chemical engineering. He is a member of the American Institute of Chemical Engineers.

Julian C. Smith

NOMOGRAPH FINDS CONDENSATE FILM TEMPERATURES. PAGE 150.

Professor Julian Smith has been on Cornell University's chemical engineering staff since 1946.

Before that time, he worked as a development engineer and group head of Du Pont's industrial engineering division, between the years 1942 and 1946.

A graduate of Cornell himself, Smith earned a bachelor's degree in chemistry in 1941 and stayed on the following year to take on a bachelor's in chemical engineering.

Present consulting work includes projects for the Orchem and Elastomer Chemical Department of Du Pont, for Corning Glass Works, and for the U. S. Army Corps of Engineers.

In the past, he also handled consulting assignments for Interchemical Co., Southern Production Co., and Danciger Oil & Refining Co.

On top of his teaching duties, Professor Smith served as project director of soil solidification research at Cornell, from 1950 through 1954. The project was sponsored by the U. S. Army Corps of Engrs., Ft. Belvoir, Va.

Among the many technical publications—some 40 or so—which he has to his credit, Julian Smith is also Co-Author with W. L. McCabe of "Unit Operations of Chemical Engineering," published by McGraw-Hill.

Smith is a member of the American Institute of Chemical Engineers, the American Chemical Society, the American Society for Engineering Education and a fellow of the American Institute of Chemists.

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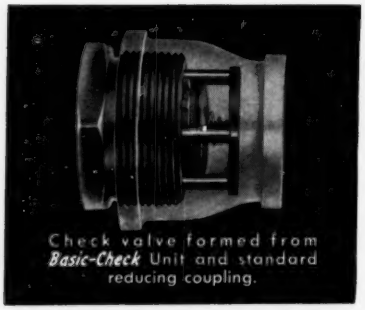

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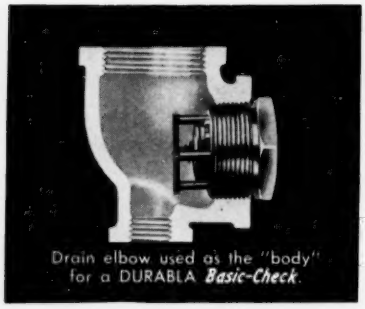

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AUTHORS . . .

Thomas Joyce

HOW TO ALLOCATE PROCESS STEAM COSTS. PAGE 152.

Like Co-Author Katell, Thomas Joyce is with the U. S. Bureau of Mines in Morgantown, W. Va. He works as a chemical engineer on the process economics evaluation staff, branch of coal gasification.

Previously, Joyce worked with American Cyanamid in Willow Island, W. Va. There, for four years, he was a production supervisor and process engineer.

Joyce earned his bachelor of science degree in chemical engineering at West Virginia University, in 1951.

The Joyce's have three little girls: aged 4, 3 and 1. What spare time he doesn't spend with them is usually devoted to bowling (in the novice class) and to other sports.

Sidney Katell

HOW TO ALLOCATE PROCESS STEAM COSTS. PAGE 152.

Chief of the process economics evaluation staff, branch of coal gasification, for the U. S. Bureau of Mines, Sidney Katell is at

present located at the Bureau's Morgantown, W. Va., operation.

Previous work experience includes: design engineer in the TVA's department of chemical engineering, Muscle Shoals, Ala.; design and cost engineer for the Louisiana, Mo., demonstration plant of the U. S. Bureau of Mines; senior project engineer for Westinghouse Electric Corp., in East Pittsburgh, Pa.

Katell is the author or coauthor of several articles dealing with cost estimation and equipment design. He is a registered professional engineer in the State of Missouri and holds membership in the Nuclear Engineering division of the American Institute of Chemical Engineers. Other professional affiliations include the American Association of Cost Engineers. In the later society, he not only is an active member but is listed as a founding member as well.

Katell earned his bachelor's degree in chemical engineering, in 1941, from New York University.

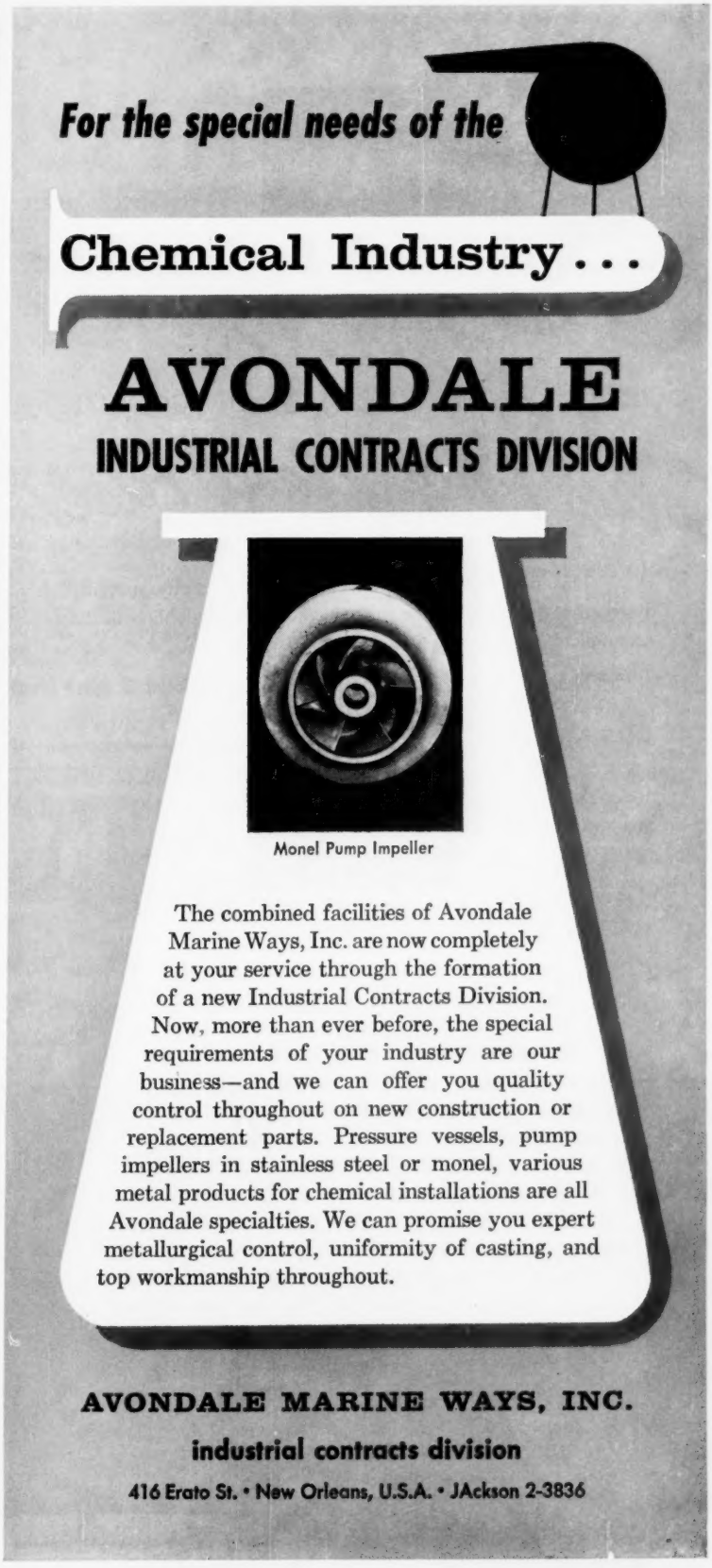
Author Katell reports an interest in photography and gardening while his "unusual hobbies involve keeping up with the interests of two preschool boys."

Charles G. Manly

NUCLEAR POWER FUTURE. PAGE 133.

Charles Manly is a government career employee. For a number of years, he worked with the office, chief of engineers of the U. S. Army in a variety of posts. Service locales included Washington, Florida, and Mexico.

He joined the U. S. Atomic Energy Commission staff early in 1948 and rose to become deputy assistant director of its reactor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AUTHORS . . .

development division and chief of its industrial liaison branch.

In 1955, the commission organized the division of civilian application and Manly was appointed to head up its commercial development branch.

Recently, he was named assistant director for commercial development of the commission's new office of industrial development. In that capacity, work still involves assisting the development and growth of a self-sufficient atomic energy industry.

F. R. Drahos

RIGHT MATERIAL CUTS PUMP CORROSION. PAGE 162.

Metallurgist F. R. Drahos holds a senior post with John Rousselot & Associates, Inc.—a Los Angeles public relations and management consulting outfit.

Responsibilities include the selection, testing and processing of materials for routine and special centrifugal pumping applications, corrosion evaluation and consultation reports on materials for new or existing uses.

At one time or another, he has been connected with metallurgical and fabrication operations for nuclear pumps for most of the major nuclear plant and laboratories in the United States.

Drahos studied at the University of Iowa. Later, he did extension work at the University of Southern California and at California Institute of Technology.

Memberships include the American Society for Metals and the National Association of Corrosion Engineers. He is also a past president of the Los Angeles section of the American Welding Society.

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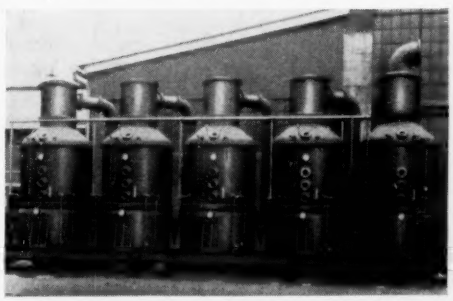
Whatever your requirements in castings may be, we are certain that you will find Kutztown services more than adequate. Your inquiry is most welcome!



We'll be happy to place your name on our mailing list to receive regular issues of the "KUTZTOWN REVIEW".

• GRAY IRON • PRESSURE IRON • HIGH TENSILE IRON
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KUTZTOWN FOUNDRY & MACHINE CORP.
KUTZTOWN, PENNSYLVANIA

You Pay Less...

(per month of service)

for

CHEMPRO TEFLON* PACKINGS

Long Life Chempro Teflon Packings last for many months under corrosive conditions which destroy conventional packings in days . . . even hours. Replacement cost on the basis of service life cannot be compared.

Ideal for sealing pump and other rotating shafts against acids, caustics, aromatics, chlorinated hydrocarbons and other powerful corrosives. What's more, they give a *truly tight seal* with only slight gland pressure. Their low coefficient of friction makes lubrication unnecessary. See Bulletin CP 552.

3 types...

- TEFLON RING SETS
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THE ORIGINAL FABRICATORS OF TEFLON PACKINGS AND GASKETS

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5 Broadway, New York 4, N. Y.

Liquid heating problems?

Call the Chromalox man for the **ANSWERS**

Regardless of the liquid, or your problems in heating it . . . it's a safe bet your Chromalox® Representative has time and money saving answers for you. Backed by the world's most complete electric heating line, he has heaters specifically designed for oils, water, asphalt, paraffin, salt baths, corrosive solutions and heat transfer media. To best suit your application, he has . . .

- Strip, tubular and ring heaters that clamp on, to heat tanks, pipes and kettles by contact.
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- Completely "packaged" heat exchangers for water, oil, steam superheating, gases, heat transfer media.
- Neoprene or silicone covered heating cable and flexible woven heaters for hundreds of "wrap-around" applications.

Where but Chromalox can you find such a wide variety? Standard heaters to fit most jobs are ready for immediate shipment from the world's largest stock. What's more, your Chromalox Representative offers factory design-engineering service for special applications.

Get the best answers to all your liquid heating problems. For information on new installations, or assistance in converting an existing system, call or write your Chromalox Sales Engineering Representative. He has the electrical answer that's fast, clean, safe, accurate and economical.

C-2108

CHROMALOX® Electric Heat

Edwin L. Wiegand Company

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ELECTRICAL ANSWERS
to your heating problems

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HOpkins 7-3280

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PEOPLE...

LETTERS: PRO & CON

C. H. CHILTON

BRITISH PILOT PLANT: Process differs in certain details.

Benzene Refining in Germany

Sir:

In your October *Chementator* (p. 140) you published an item headed "New H_2 refining route for benzene." You state that this process has been developed by Britain's Coal Tar Research Assn.

The process you describe has been developed by our company. It was first patented in German Patent DBP No. 930,223, owned by our parent company, Metallgesellschaft Aktiengesellschaft, with priority date May 22, 1953.

Our company built the first commercial plant for the refining of crude benzene with coke-oven gas for Nuremberg Gas Works in 1953. A report about the results of this plant was published in *Brennstoff-Chemie*, Oct. 20, 1954.

Subsequently, our process was developed further in cooperation with BASF and Scholven-Chemie. More than ten large industrial plants for the direct refining of crude benzene with coke-oven gas are in operation or under construction at present.

(SIGNATURE ILLEGIBLE)
Lurgi Gesellschaft fuer
Mineraloeltechnik m.b.H.
Frankfurt am Main, Germany

▶ *Before publishing our story, we first checked with the British group to make sure its process really was different from the Lurgi-BASF-Scholven process. It is admittedly similar in basic objective but differs in details which at present are confidential. The pilot-plant photo above is evidence that CTRA is carrying on original, independent process development work.*

Significantly, we first described the Scholven process for

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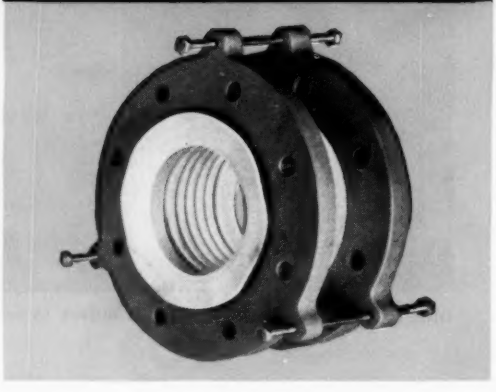
. . . with protecting Jackets of du Pont TEFLON, are impervious to chemical attack. Made with a variety of filler constructions to suit every connection problem—every pipe and nozzle material requirement—whether glass, ceramics, stainless, Karbate, Haveg, glass-lined steel, etc. That is why Garlock 8764 Chemiseal Gaskets have become the standard choice of the process industries. Catalog AD-154.

top team for chemical piping



Chemiseal® Expansion Joints

. . . and Flexible Couplings, made of chemically impervious du Pont TEFLON, protect costly piping against shock and vibration, thermal expansion and contraction. Correct misalignment. Connect unlike piping ends and nozzles. Eliminate slip-joints, gaskets, adaptors. Companion Products to the famous Garlock Rubber Expansion Joints. Catalog No. AD-137.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
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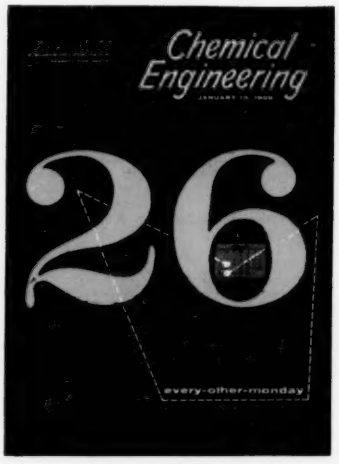
Plastics Division of GARLOCK

PRO & CON . . .

refining benzene with coke-oven gas back in September 1952 (p. 220), well before Lurgi's 1954 publication. The Scholven plant went commercial in 1950, was expanded in 1951.—ED.



Pro: Big Orange 26

Sir:

I have just finished reading the first of your biweekly issues, and if this is a sample of what's to come, it appears that *Chemical Engineering* is certainly going to have a fine year.

Good luck in your new publishing schedule, and keep up the fine articles.

DWAIN F. SPENCER
W. Lafayette, Ind.

▶ *Mr. Spencer's letter was the very first we received commenting on our new biweekly frequency. Other typical reader reactions follow below.*—ED.

Sir:

I think your new publishing frequency has just about quadrupled the value of your magazine to me. Since I subscribe to several other business and technical publications, I didn't use to find the time to read the thick issues of *Chemical Engineering* very carefully. I certainly like the new, slim look.

JOHN T. CARLETON
E. I. du Pont de Nemours & Co.
Aiken, S. C.

Sir:

After looking over the first biweekly issue of *Chemical Engineering* I send you my congratu-

lations on a wonderful job. I cannot think of a single suggestion to offer which I think might improve the magazine.

The job you have done has increased my "must" reading. Before this change I had usually only scanned through the issue. Now it has so many fine things that I find I must spend more time with it.

P. D. V. MANNING
International Minerals & Chemical Corp.
Chicago, Ill.

Sir:

The January 13, 1958, issue of *Chemical Engineering* arrived a few days ago, and it is a decided change for the better in that I can get through it in a single evening. My only complaint about the older format was that it was difficult to assimilate in one sitting.

CHARLES E. BILLINGS
Boston, Mass.

Sir:

Congratulations on your change to biweekly publication. This is a real improvement.

I would like to see you carry a lot of articles on production costs and investments in various size plants producing chemicals.

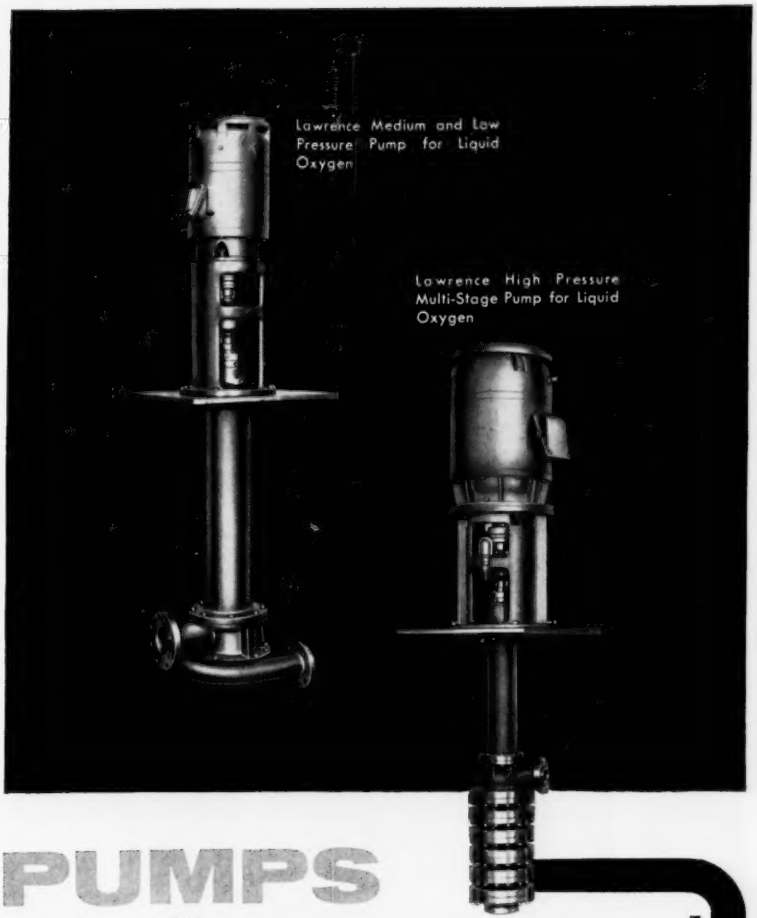
MARION BROWN
Mississippi Chemical Corp.
Yazoo City, Miss.

▶ *We, too, would like to publish more articles on production costs —actual costs, that is, not just estimates. Whenever we can get the information, we include in our feature process stories and flowsheets significant data on unit consumptions of raw materials, utilities and labor. But more often than not such data are confidential and can't be published.*—ED.

On Evaluating Investments

Sir:

Mr. Sandel (*Chem. Eng.*, Nov. 1957, p. 231) has touched on a point which all executives and men who evaluate capital investments for their companies should weigh carefully. Management should be completely aware of all outlays of company assets in connection with a project; otherwise, they are committing the company to using more



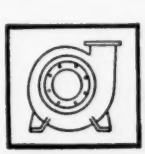
PUMPS
to handle **LIQUID OXYGEN** *and other* **LIQUEFIED GASES**

Lawrence Pumps Inc. has developed a special line of pumps for handling liquid oxygen, liquid nitrogen and other gases which can be liquified only at very low temperatures.

Because of the abnormal behavior of materials and liquids at extreme low temperature several of the following features are incorporated in these pumps:

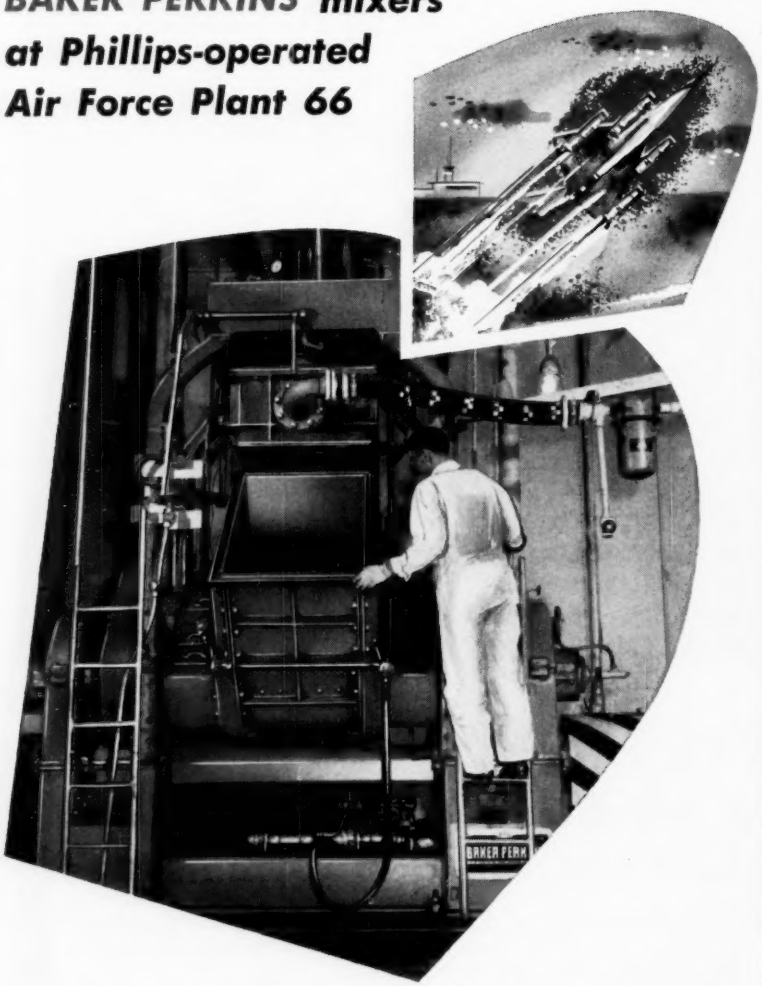
1. Vertical top suction construction to prevent gas binding when the NPSH drops below the safe level, due either to drop in suction pressure, or rise in temperature of the liquid.
2. The packing box does not come in contact with the liquid, only with the blanket of gas in the pipe column.
3. The packing box is fitted with a mechanical seal which has been developed especially for this exacting service.
4. The design has been carefully developed and the materials selected to eliminate any troubles due to differences in expansion and to prevent galling between running parts.

Write for bulletin 203-7



LAWRENCE PUMPS INC.
371 Market Street, Lawrence, Mass.

Jato motor fuel is accurately blended in BAKER PERKINS mixers at Phillips-operated Air Force Plant 66*



Jet-assisted-takeoffs* (JATO) enable heavy aircraft to become airborne quickly and safely from limited length areas. For the precise task of mixing all-important rocket fuel used in these powerful JATO units, Phillips Petroleum Company, McGregor, Texas, uses dependable Baker Perkins Size 15 Dispersion Mixers.

A combination of vacuum-and-compression cover effectively seals the 15 VUEM2 B-P mixer, which is completely jacketed. Each of these machines has a working capacity of 100 gallons and a total capacity of 200 gallons. The 150 hp drive motor efficiently powers these units thru hour after hour of reliable, trouble-free operation.

This is just one of the many processes to which B-P high-performance mixers are instantly applicable. Write for the complete Baker Perkins catalog . . . or consult your experienced B-P sales engineer.

BAKER PERKINS INC.

354

CHEMICAL MACHINERY DIVISION • SAGINAW, MICHIGAN

funds than are actually being set aside for the project, and the return on the company's total assets will be lower than anticipated.

I like to look at some of the not-so-obvious costs in this way:

If a new company were being formed to handle just the new project, it would be necessary to invest more than just the money required to build the new plant before the new enterprise could be launched. Only after all the items enumerated and discussed so well by Mr. Sandel are taken into consideration would you have a going concern.

Management, in its evaluation of the projects, may wish to require a different rate of return on those items which involve essentially no risk, such as some inventories and accounts receivable. However, this is up to the individual company management to decide.

Mr. Sandel has dealt with a subject which is very timely as capital money becomes shorter in supply and is more expensive to obtain.

H. L. CHILDRESS
California Oil Co.
Perth Amboy, N. J.

Pro: Top Ten Trends

Sir:

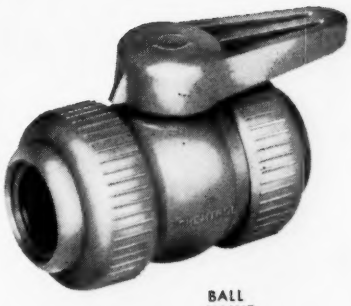
I have just been reading your January 13 issue. Nice going, particularly your presentation of the top ten technical trends.

Having paid you that compliment, I would suggest that you check your records on Carborundum Metals (p. 128). Their plant is at Akron, N. Y., not Akron, Ohio.

H. B. LOWE
Chemical Engineering Catalog
New York, N. Y.

► *It might be easier, in the long run, for the town of Akron, N. Y., to change its name than for us old dogs to learn ne v geography.*—ED.

HOW TO GET
FULL FLOW
LONGER LIFE...
from your
PIPING
SYSTEM
...specify



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CHEMTROL corrosion-resistant
PLASTIC VALVES

NEW! DIFFERENT!

Advanced corrosion-service plastic valves of PVC (Polyvinyl Chloride), Type I and Type II; Penton*; Kralastic**; Polypropylene (Pro-fax*); and other polymer materials have lower first, and reduced maintenance costs (up to 80% less over service range). The ONLY complete line — with widest range of types and sizes. 5 year guarantee.

A FULL LINE OF PLASTIC VALVES

Micro-Meter NEEDLE VALVES

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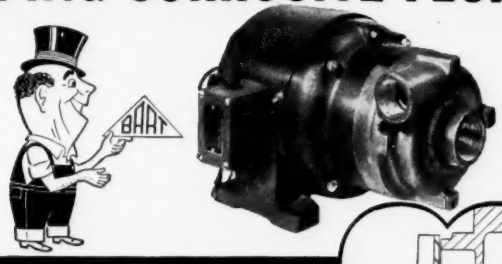
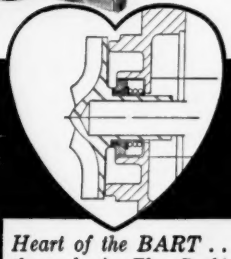
now! greater ***safety*** *and* ***efficiency*** *in*
PUMPING CORROSIVE FLUIDS



BART
FLEX-SEAL
CENTRIFUGAL PUMPS



At last—a full line of pumps *specifically designed* to handle corrosive and abrasive fluids in the 1 to 80 GPM range, at heads to 75 feet.

No longer need you cut down bigger pumps in range and lose efficiency—or put up with undependable smaller pumps.

Bart pumps have fewer parts to wear or get out of order. Six models, each in corrosion resistant Type 20 Stainless Steel. Or other alloys on special order.

Write for catalog and performance curves.

Heart of the BART . . .
the exclusive Flex-Seal!

Effectively minimizes a long-prevalent basic weakness of centrifugal pump design. Self-adjusting to wear. Needs no external lubrication. Carbon stator/ceramic seat, unexcelled for long wear—or zircon filled Teflon/work-hardened Type 20 Stainless Steel, for severest corrosive service.

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ELECTROFORMING • PIPE LINING & COATING • PLATERS • PUMPS • ENGINEERING DESIGN SERVICES
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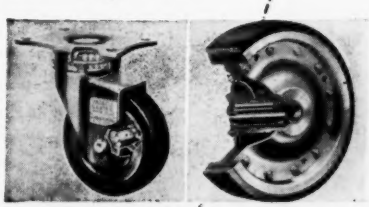
good reasons to rely on



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RUBBER TREADS . . . a wide choice of treads suited to all types of floors, including Darnelloprene oil, water and chemical-resistant treads, make Darnell Casters and Wheels highly adapted to rough usage.

2.
RUST-PROOFED . . . by zinc plating, Darnell Casters give longer, care-free life wherever water, steam and corroding chemicals are freely used.

3.
LUBRICATION . . . all swivel and wheel bearings are factory packed with a high quality grease that "stands up" under attack by heat and water. Quick grease-gun lubrication provides easy maintenance.

4.
STRING GUARDS . . . Even though string and ravelings may wind around the hub, these string guards insure easy rolling at all times.

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Whatever your tubing needs—for oil field, refinery, bulk plant, transportation equipment—let Penflex meet them with *flexible*, corrugated or interlocked tubing available in bronze, galvanized or stainless steel tubing in sizes from 1/8" to 24" I.D. For full data write Pennsylvania Flexible Metallic Tubing Company, Inc., 7234 Powers Lane, Phila. 42.

GET YOUR COPY of this practical, helpful guide to flexible tubing.

PENFLEX

TIGHT AS A PIPE BUT...

FLEXIBLE

PEOPLE . . .

NAMES IN THE NEWS

M. A. GIBBONS

William H. Rader

William H. Rader has been made U. S. Industrial Chemical Co.'s assistant production manager for Petrothene polyethylene resins.

After completing his military service with the navy in 1946, Rader resumed studies at Illinois Institute of Technology and received his chemical engineering degree in 1948.

Upon graduation, he joined the chemical products division of Esso Standard Oil Co. until 1953, when he joined National Distillers' subsidiary, National Petro-Chemicals Corp., as senior technologist.

Rader has performed customer service work and, as senior development engineer, had charge of polyethylene development operations at the company's Tuscola plant.

E. Leonard Borg has been named manager of synthetic rubber development for the Naugatuck Chemical Division, U. S. Rubber Co.

Kazuo Kiyonaga recently joined the staff of Tonawanda Laboratories, Linde Co., and is presently working in the development laboratory. Prior to joining Linde, he was employed by M. W. Kellogg Co.

J. R. Cutler succeeds **J. J. Rasor,** resigned, as assistant superintendent of Texaco's West Tulsa refinery. Before his appointment, Cutler was assistant superintendent of light oil processing of the manufacturing department of Texaco's Port Arthur, Tex., refinery.

John H. Smith has been appointed to the newly created post of chief design coordinator in Sun Oil Co.'s manufacturing engineering division. He assumes general supervision of the division's design section.

Gilbert G. Schneider

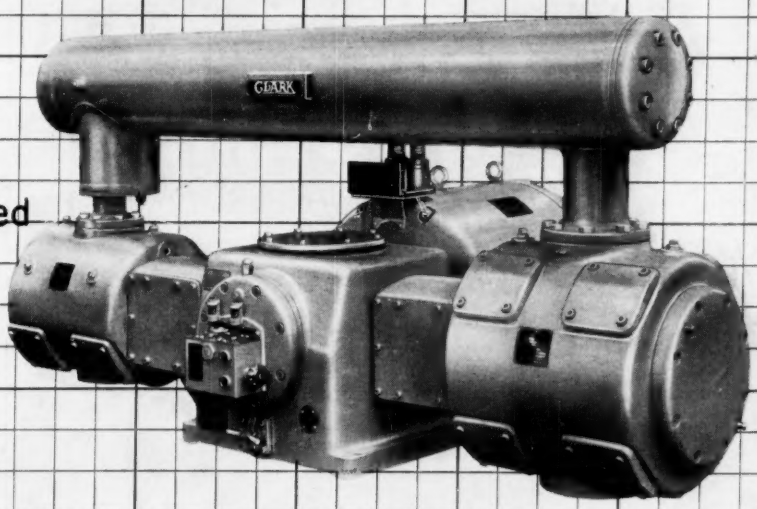
Western Precipitation Co., a leader in the field of dust, fume and fly ash control, has announced the appointment of Gilbert G. Schneider to head up the sales department for its new product line, Doyle-Turbulaire scrubbers.

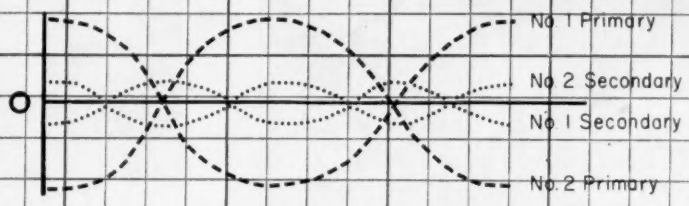
A chemical engineering graduate from Rensselaer Polytechnic Institute, Schneider joined Western Precipitation in 1951 as a test engineer. He subsequently served in various engineering and sales capacities in the firm's Los Angeles, New York, Atlanta and Pittsburgh offices.

Neil T. Fitzmorris has joined Redel Inc. as a chemical engineer in the research and development division to specialize in rocket propellant ignition and combustion studies.

Edward W. Marlier has been appointed to the post of mana-

Clark introduces
the ICA-6
Balanced / Opposed
Compressor





Never before an industrial air compressor with such

PERFECT BALANCE

...so many engineering advancements

Newest and smallest in the Clark-originated line of balanced/opposed compressors – the ICA-6 enables you to put your air service close by your production equipment or assembly operations. Because the balanced/opposed design is practically vibrationless, you can mount the compact Clark ICA-6 anywhere—on upper floors, on steel framework, on piling, ships or railroad cars. And since there is no vibration to worry about, the foundation need only be large enough to support the weight of the compressor. You also save substantially on piping and distribution losses.

Available in 75 and 100 hp models, the new 6″ stroke ICA-6 is built to the same exacting standards of quality and workmanship as the larger Clark 8″, 14″ and 17″ stroke balanced/opposed compressors.

Many engineering advancements resulting from Clark's *encyclopedia of experience* are incorporated in the new ICA-6. Your nearby Clark engineer will give you all the facts. Contact him or write Clark Bros. Co., 1806 Lincoln Avenue, Olean, New York for Bulletin 161.

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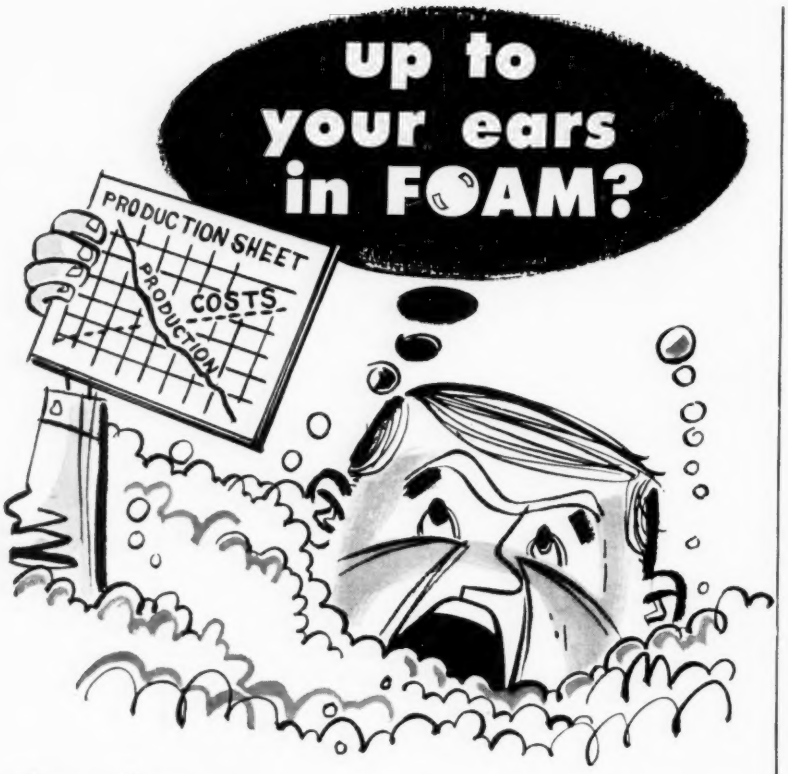

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Oil system
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ger, industrial chemicals department, Chas. Pfizer & Co.'s chemical sales division.

Harry E. Olsson has been elected vice president in charge of production at the Newark, Calif., plant of Leslie Salt Co. Formerly production manager, Olsson succeeds Joseph C. Buchen who has retired.

Fred J. Emmerich

The Chemical Industry Medal for 1958—"for conspicuous services to applied chemistry"—has been awarded to Fred J. Emmerich, past chairman of the board of directors of Allied Chemical & Dye Corp.

Nationally known as a scientific and industrial administrator, Emmerich is recognized for his application of scientific principles to the practical problems of industrial growth and development, particularly through Allied Chemical and the Manufacturing Chemists' Association.

Emmerich retired as chairman of Allied Chemical's board of directors on December 31, 1957, after 37 years with the company. He continues as a director.

William E. Wivell has been named manager of process engineering, International Minerals & Chemical Corp. He will be in charge of the chemical and mineral processing activities of the company's engineering division.

Mats-Olaf Macklin has been appointed liaison development engineer for the Hays Corp., Michigan City, Ind. Previ-

ously he was employed by Du Pont as a development engineer.

Lamar P. Bupp has been appointed manager, chemical research and development operation, at General Electric Co.'s Hanford Atomic Products Operation, Richland, Wash. Since joining the Hanford staff in 1950, he has been doing reactor technology and materials work as a chemist, technical group leader, and in managerial positions.

David W. Montgomery has been named senior technical man at the B. F. Goodrich Chemical Co. development center, Avon Lake, Ohio.

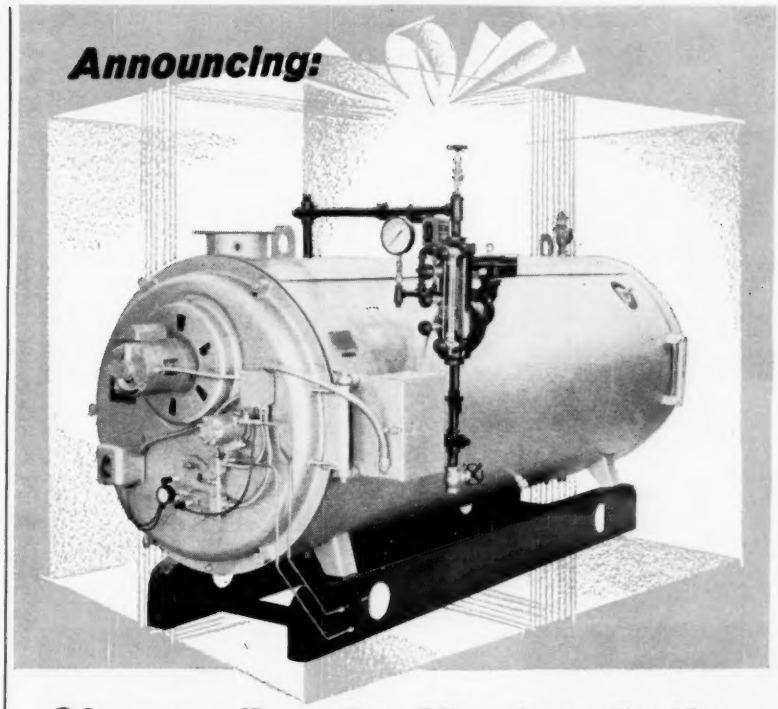
E. D. Redding

E. D. Redding has been named a vice president of Wyatt C. Hedrick Engineering Corp., Houston, Tex.

With some 17 years in the planning, design and construction of petrochemical, chlor-alkali and natural gas facilities, (the last six with Hedrick) Redding will be responsible for consulting services, economic development studies and process engineering.

He had previously served as project engineer, chief development engineer and executive assistant.

Joseph K. Goerner and **Ben C. Hayton** have been appointed to two product manager posts with Jefferson Chemical Co., Houston, Tex. Goerner is manager of specialty products; Hayton, manager of



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- **Long operating life** resulting from rugged construction and time-tested five square feet of heating surface per boiler horsepower.
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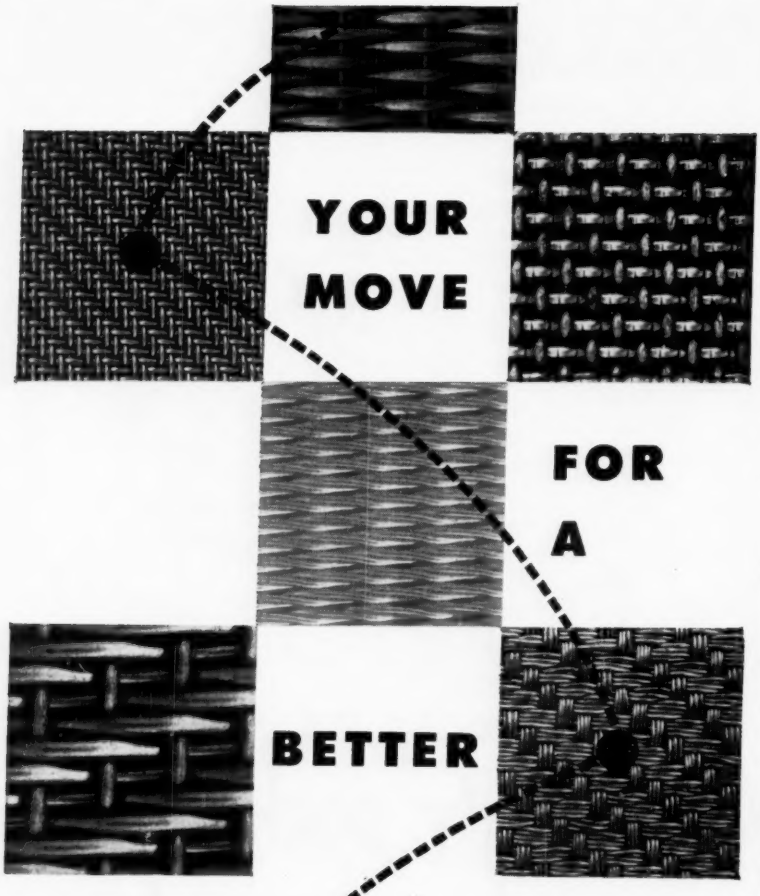

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glycol products. Both men will report to the general manager of the company's marketing department.

Leroy A. Claybaker has been appointed supervisor of manufacturing at General Electric's phenolic varnish operation, Coshocton, Ohio.

Alexander F. Baillio has been promoted to director of General Motors patent section, succeeding **George H. Willits** who is retiring. Baillio attended the University of Virginia and George Washington University where he majored in chemical engineering. He is also a graduate of the Detroit College of Law.

Myron G. DeFries

Atlantic Research Corp., consulting research and development firm in Alexandria, Va., has appointed Myron G. DeFries as head of its chemistry group.

A graduate chemical engineer from C.C.N.Y., DeFries has been a member of ARC's chemistry group for the past two years. The group is engaged primarily in applications research in adhesives, laminates, foams, studies and improvements of solid propellant physical properties.

Before joining ARC, DeFries was chief of the test section at the Army Prosthetics Research Laboratory, and previously was a chemical engineer with Rohm & Haas Co., Bristol, Pa.

His articles on high polymers and plastics as applied to the field of prosthetics have been published in a number of technical publications.

B. W. Jesser

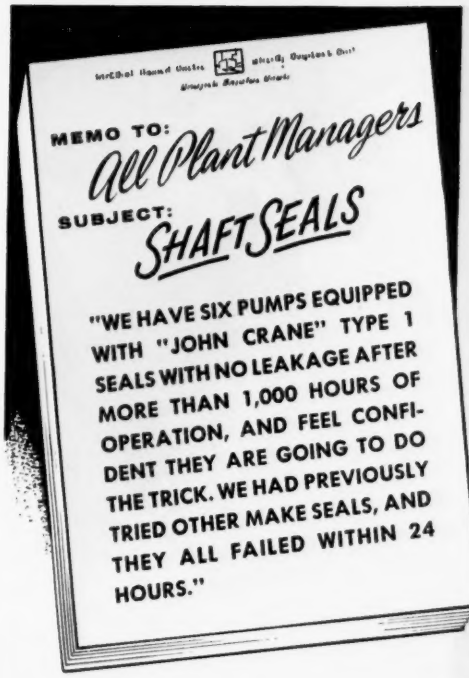
The board of directors of Kellogg International Corp., London, subsidiary of M. W. Kellogg, has named B. W. Jesser as manager of the corporation. Jesser relieves F. E. Johnson, Jr., who has been made an assistant engineering vice president of the parent company in N. Y.

With Kellogg since 1942, Jesser has served as contract operations engineer in the N. Y. office and manager of the company's design engineering department. Prior to this, he was a chemical engineering instructor at Princeton and was with Du Pont.

Robert P. Cahn has been named an engineering associate in the planning engineering division of Esso Research and Engineering Co. A recently created position, the post of engineering associate is in line with the company's plan of offering a course of promotion, prestige and recognition along technical lines equivalent to the channel of advancement in administrative activities.

Alfred M. Cox, president of J. P. Devine Manufacturing Co., process equipment manufacturer, has been elected president of the Smaller Manufacturers Council, Pittsburgh, Pa.

Myers F. Gribbins, Jac O. Ullman and **Frank G. Keenen** have been appointed to new positions in Du Pont's polychemicals department. Gribbins, formerly assistant sales manager of the nitrogen products section, has been named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All Plant Managers
SUBJECT:
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"WE HAVE SIX PUMPS EQUIPPED WITH "JOHN CRANE" TYPE 1 SEALS WITH NO LEAKAGE AFTER MORE THAN 1,000 HOURS OF OPERATION, AND FEEL CONFIDENT THEY ARE GOING TO DO THE TRICK. WE HAD PREVIOUSLY TRIED OTHER MAKE SEALS, AND THEY ALL FAILED WITHIN 24 HOURS."

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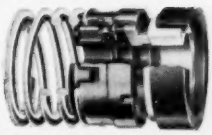

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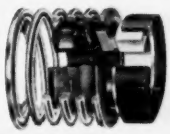
Designed for limited stuffing box diameter. Handles water, light hydrocarbons, refrigerants, mild acids and other liquids non-injurious to synthetic rubber at temperatures from −40°F. to +212°F., pressures to 200 psi.



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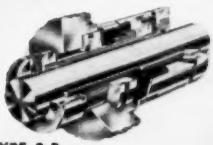
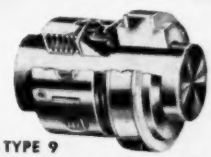
Designed for limited stuffing box length. Handles same services, temperatures and pressures as Type 1.



TYPE 8-B
Heavy duty, high pressures. Packaged construction for easy installation. Handles pressures to 1200 psi., temperatures from −40°F. to +250°F. Services same as Type 1.



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Buffalo, N. Y.	GA 6374	Oklahoma City, Okla.	FO 5-3301
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Charlotte, N. C.	FR 5-7704	Peoria, Ill.	5-2461
Chicago, Ill.	TA 9-2651	Philadelphia, Pa.	PO 5-7400
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Cleveland Heights, Ohio	ER 1-3457	Pittsburgh, Pa.	CH 2-5551
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Denver, Colo.	AL 5-5406	Salt Lake City, Utah	HU 4-5854
Des Moines, Iowa	CH 3-3357	Seattle, Wash.	SU 2192
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NAMES . . .

manager of the ammonia products section. Ullman, former product specialist with the plastics sales division, replaces Gribbins. Keenen moves from the post of manager of the ammonia products section to associate laboratory director for the department's sales service laboratory at Chestnut Run, near Wilmington, Del.

Louis T. Monson

Louis T. Monson, formerly chief chemist of Petrolite Corp.'s Tretolite Co. of California Division, succeeds Glenn W. Camblin (retired) as vice president of Petrolite and general manager of Tretolite.

Monson, a chemical engineering graduate of Washington University, St. Louis, is the inventor or co-inventor of 49 U. S. patents. He is active in the American Petroleum Institute and the National Association of Corrosion Engineers.

L. T. Vice has been named a vice president of California Commercial Co., wholly-owned subsidiary of Standard Oil Co. of Calif. He will direct the firm's Washington, D. C., offices. Before his new assignment, Vice was chief engineer for manufacturing and sales in the El Paso office of Standard Oil Co. of Texas, another Standard of California subsidiary.

Stanford B. Spracklen, co-developer of the first industrial gas chromatograph for continuous stream analysis and control, has been named associate director of research and

engineering for the process instruments division of Beckman Instruments, Fullerton, Calif.

Jack Arnold, Jr.

Jack Arnold, Jr., has been appointed supervisor of Enjay Co.'s Boston office, a position he has been filling on a rotational basis since April, 1957.

Before joining Enjay, Arnold served as an industrial salesman with an affiliated company. He joined Enjay in 1955, working in polymer sales in New England.

Alexander Brown has been appointed assistant director of research for Bakelite Co. He was formerly a section head in the research laboratory at Bloomfield, N. J.

J. C. Lawrence of Moylan, Pa., was nominated by the AIChE and elected a director of the American Standards Association.

Jack H. Venarde has been appointed as a senior chemical engineer in Atlas Powder Co.'s chemical engineering department.

Donald J. McPherson, an authority in the field of titanium and its alloys, has been named manager of the metals research department at Armour Research Foundation of Illinois Institute of Technology.

George P. Knox, Jr., group leader in the organic process development laboratory at Dow Chemical Co.'s Freeport,

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NAMES . . .

Tex., plant, has been promoted to assistant director of the laboratory.

Clyde Williams has resigned as president of Battelle Institute and has formed a new company, Clyde Williams and Co., to assist top management in industry with technical and business problems. He will continue to serve Battelle as a member of the board of trustees and in a consulting and advisory capacity.

Harold W. Fleming

Harold W. Fleming has been named director of research for Catalysts and Chemicals Inc., Louisville, Ky.

Fleming became interested in catalytic research when he began his career with Sherwin Williams Co. Later he joined Phillips Petroleum Co. performing research principally in catalytic hydrogenation of petroleum stocks and in Fischer-Tropsch synthesis reactions.

Before joining Catalysts and Chemicals, Fleming was research director of Girdler Co.'s catalyst department. He holds numerous patents and has authored many articles in the catalytic field.

Frank P. Green has been elected president of Plumb Chemical Corp., Philadelphia, manufacturers of fiber-glass reinforced molding compounds.

R. Victor Harris has been appointed general manager of the instrument division, Perkin-Elmer Corp. He succeeds Dr. Van Zandt Williams, who was recently named

executive vice president of company.

J. W. Luthy has been appointed director of applications for the dyestuff and chemical divisions of Sandoz, Inc. He was associated with General Aniline & Film Corp., process development department, before joining Sandoz in 1948.

George Manov, former technical assistant to A. E. C. Commissioner W. Libby, has become technical director of Tracerlab's reactor monitoring center in Richmond, Calif.

Edwin "Pete" Cox, long associated with Virginia-Carolina Chemical Corp., is now in practice as a chemist and chemical engineer with office and laboratory at Aylett, Va.

Robert G. Schmidt, manager of the Lawrence division, Callery Chemical Co., has moved to Lawrence from Pittsburgh.

E. Kenneth Burger, a chemical market research expert with Esso Standard Oil Co., has retired from the company, but will be retained as a consultant. Burger is a past president of the Chemical Market Research Association.

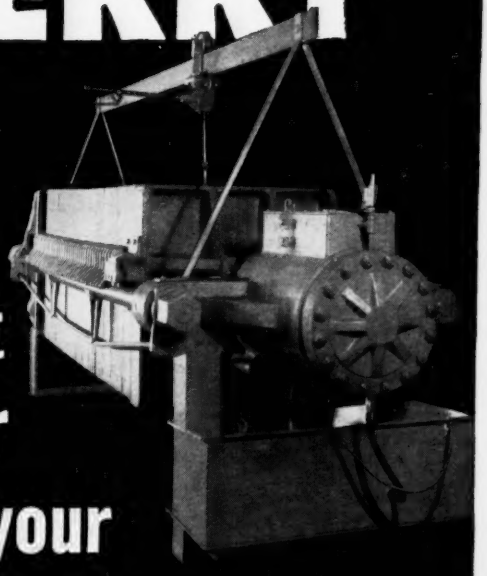
Chancelor E. Lacy has been appointed manager, engineering department of Hardinge Co.

OBITUARIES

John H. Merell, honorary director of Raybestos-Manhattan, died January 4 at Chicago. Merrell started with the Manhattan Rubber Manufacturing Co., now the Manhattan Rubber Division, in 1903, at the Chicago branch office. Later he became Chicago branch manager, vice president and director of Raybestos-Manhattan.

Carlos E. Bronson, former vice president and chief engineer of the Kewanee Boiler Division, American Radiator and Standard Sanitary Corp., died at his home in Kewanee, Ill., January 21. He was 71.

SPERRY



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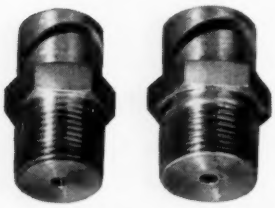

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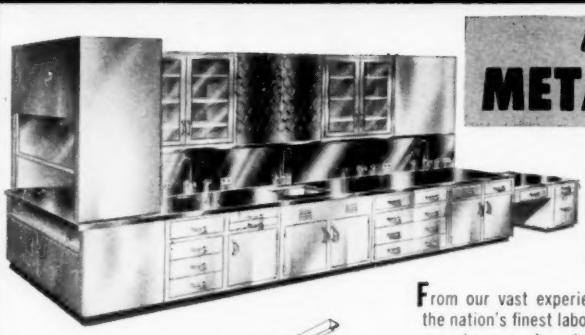

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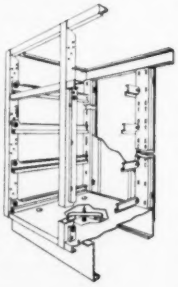

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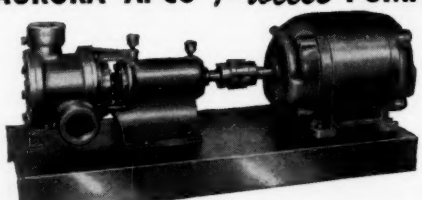

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PEOPLE . . .

FIRMS IN THE NEWS

R. A. LABINE

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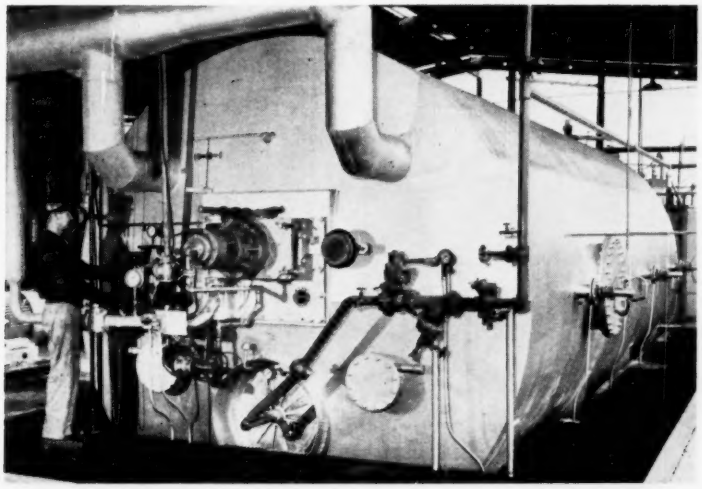


New Sludge Acid Burner Yields Fresh Sulfuric

U. S. Industrial Chemicals' latest addition at its Sunflower, Kan., plant: A spent acid decomposition and purification unit. It can handle 70 tons/day spent acid, generates SO_2 for conversion back into pure sulfuric acid.

Fremont Minerals is planning a suifuric acid plant in Riverton, Wyo., adjacent to firm's abuilding uranium mill. Capacity has not been established, but will fill processing needs of the Riverton and Edgemont, S. D., mills.

Elgin National Watch Co.'s Micronics Div. will occupy a new 60,000-sq.-ft. plant in Chicago area on Sept. 1. Some 100 employees will be housed in the $1-million facility.

Humble Oil & Refining Co. has started up a new benzene plant at its Baytown, Tex., refinery; design capacity is 30 million gal./yr. high-purity benzene. Company is also expanding paraxylene production at Baytown to 66 million lb./yr.

Merck is planning a new $5-million silicon processing plant to be erected in Danville, Pa. Wigton-Abbott Corp. will design process to turn out the ultra-pure silicon used by electronics industries.

Rust-Oleum Corp., Evanston, Ill., has completed a $600,000 plant expansion. Among new production facilities is a 12,000-sq.-ft. warehousing unit, new ball mill equipment and automatic packaging system.

L.O.F. Glass Fibers Co. has awarded contracts totalling over $1 million for construction of a glass fiber plant in Corona, Calif. The 105,000-sq.-ft. plant is scheduled for completion by Aug. 1.

Scientific Design Co. will design a cumene manufacturing plant for British Hydrocarbon Chemicals. Unit, to be erected at Grangemouth, Scotland, will produce high-purity cumene for manufacture of phenol at same location; it's scheduled to go on stream by mid-1959.

Atlas

INSTALLATIONS PROVIDE PERMANENT CORROSION PROTECTION!

tanks

Pickling, plating, chemical processing and storage tanks of all kinds, utilizing corrosion-proof linings and cements, are designed and constructed by Atlas to completely resist all types of corrosives.

floors

Atlas industrial floors for chemical processing areas, pickling and plating rooms form a corrosion-proof base against attack by alkalies, acids, solvents and salts.

hoods, ducts, fume systems

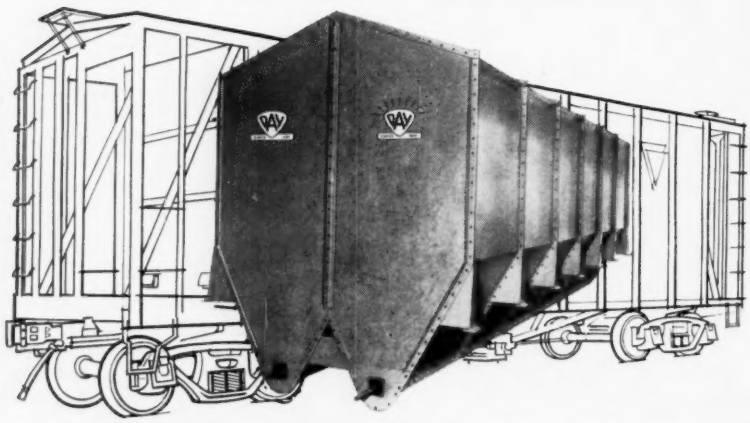
Rigid plastic structures, designed and fabricated by Atlas from polyvinyl chloride, exhaust all types of corrosive fumes. Plastic tanks and piping systems contain and convey corrosive solutions. All are completely corrosion-resistant throughout.

These Atlas installations will permanently protect your plant from corrosion. Write for Bulletin CC-3.

ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN, PENNSYLVANIA

DAY

BULK STORAGE NEWS

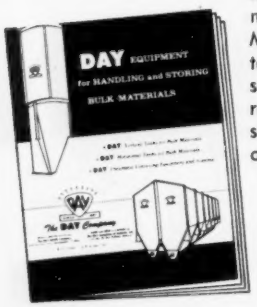


A CARLOAD OF STORAGE IN ONE 'PACKAGE'

SAVE! Store Chemicals in bulk with **DAY** Tanks

Here's a "package" that's engineered and built for heavy duty service. Compared to bags or other containers, DAY Bulk Tanks store more materials, in less space, faster, better and cheaper. By eliminating bag and labor costs they save up to 35¢ on every 100 lbs. of bulk material handled.

DAY tanks are large enough to actually store a carload or more of material in a single tank. They may be pneumatically or mechanically loaded and emptied. Made in vertical and horizontal styles, DAY tanks are built and shipped in easily erected sections. They have been proven in a wide range of applications. They are sturdily constructed of galvanized, black or stainless steels or aluminum.



Write toDAY for Bulletin 574. This 12-page booklet gives specifications plus money saving facts about sanitary, weatherproof DAY tanks.

The **DAY** *Company*

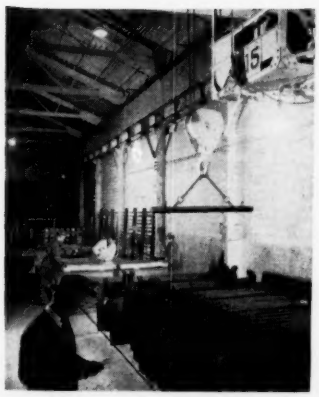
SOLD in UNITED STATES by
The DAY SALES Company
856 Third Ave. N.E., Minneapolis 13, Minn.

MADE and SOLD in CANADA by
The DAY Company of Canada Limited
P.O. Box 70N, Fort William, Ontario

Representatives in Principal Cities

EQUIPMENT ONLY OR A COMPLETE SYSTEM

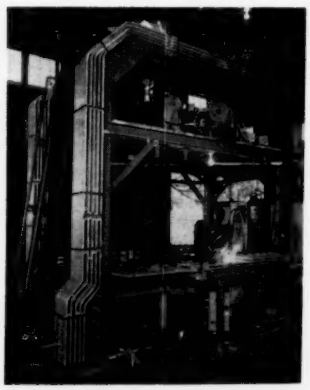
FIRMS . . .



Titanium Metals Corp. of America has opened the first titanium warehouse east of the Mississippi. Stocked with complete line of mill products, facility is geared for 24-hour shipments.

Imperial Chemical Industries is investing $30 million more in India's expanding chemical industry this year. Among ICI projects is an explosives plant at Gomia in Bihar.

Olin Mathieson's new nuclear reactor core plant at Montville, Conn., is scheduled to start production in May. Plans for a larger plant at the same site are being considered.

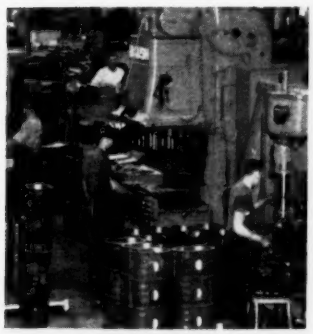


Tide Co., Louisville, Ky., has expanded facilities for heavy aluminum fabricating. Large jigs turn out 120,000-ampere welded aluminum bus bars used in high-current electric furnaces.

Nooter Corp. will spend around $700,000 for a new 23,000-sq. ft. building in St. Louis. Unit will house company's executive offices, administrative and engineering staffs.

Beckman Instruments has received a $132,000 contract to supply two analog computers to North American Aviation's Rocketdyne Div. Computers will be used to "test run" rocket and missile engines before they are built

Packless Metal Hose, Inc., has completed a modernization program at its Mount Vernon, N. Y., plant, installing automatic and semi-automatic machinery for assembling hoses, braids and fittings.



Roots-Connersville boasts a new integrated manufacturing department covering 40,000 sq. ft. Capacity for rotary positive blowers, gas pumps and positive-displacement gas meters has been boosted by 100%.

Applied Research Laboratories has opened an expanded demonstration laboratory maintaining a full line of latest spectrochemical instruments in suburban Dearborn, Mich.

Famco, Inc., glass fiber maker, has expanded facilities for producing glass fibers for the plastics industry; the Louisville, Ky., plant now boasts 174,500 sq. ft.

West Virginia Pulp & Paper Co.'s Polychemicals Div. has opened a specialized ceramic

The W-S double diamond brand mark symbolizes more than a century of pioneering manufacture in the fields of pipe fittings and hydraulic jacks and pumps.

For almost a century the Cleveland brand has marked industry's best automotive and industrial hardware and commercial forgings and die casting.

Now, the two manufacturing organizations which bear these brands have combined to continue and enlarge their line of quality products and to increase service to you through exchange of technical experience and through distribution facilities from coast to coast. Now, from one source, you may obtain the finest in forged carbon, stainless and alloy steel pipe fittings, unions and couplets; hydraulic jacks and pumps; stock forgings for trucks, buses and other vehicles; commercial forgings and die castings for all industry.

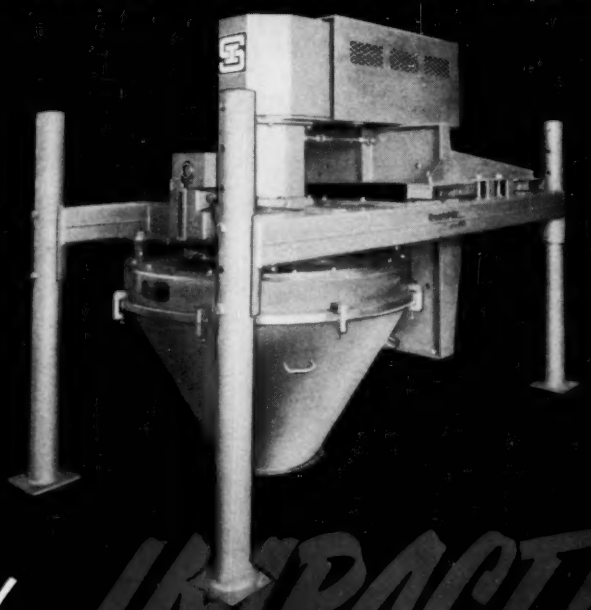
This means additional service from the growing facilities of H. K. Porter Company, Inc., where planned diversification has resulted in a product for every industrial plant.

H. K. PORTER COMPANY, INC.

FORGE AND FITTINGS DIVISION

W-S Fittings Works, Roselle, N.J. • Cleveland Forge Works, Cleveland 4, Ohio
Stainless Steel Works, Duncannon, Pa. • Cleveland Die Cast Works, Cleveland 4, Ohio

PARTICLE SIZE REDUCTION



by IMPACT!

RESULTS

PROBLEM:
To obtain closely controlled particle size reduction on a heat sensitive product near its softening point.

MATERIAL:
Polyvinyl Alcohol Resin.

SOLUTION:
Installed ENTOLETER® CentriMil . . . Series 40

EVALUATION:
1. Low Heat Rise.
2. Uniformity of Particle Size
3. Reduction of Product Loss Caused by Dust or Undesirable Fines.
4. Higher Bulk Density . . . Reduced Size of Bagging for Easier Handling . . . Cut Storage Space Requirements.
5. A Higher Quality and Dependable Product.

You may have a similar problem . . . or a completely different one. In either case, let us help you solve it . . . at lowest cost . . . with best results.

For NEW descriptive bulletins or information on FREE sample test processing in our Development Laboratory . . . contact the Entoleter Division, P. O. Box 904, New Haven, Connecticut.

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P. O. BOX 904 NEW HAVEN 4, CONN.

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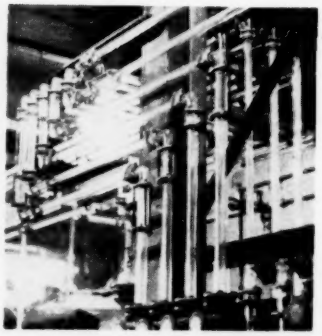
LIQUIGAS LIMITED
ELECTRICAL DIVISION
LIGHTING DIVISION
SAFETY RAILWAY SERVICE CORPORATION
ENTOLETER DIVISION
AUTOMATIC TIMING & CONTROLS, INC.
THE HOWE SCALE COMPANY
SI HANDLING SYSTEMS

laboratory in Charleston, S. C., that will be devoted exclusively to research and development of Polyfon, chemically active ceramic binder.



Heyden Newport has erected two new units at Fords, N. J.: Salicylaldehyde plant, shown above, will soon be on stream producing 1 million lb./yr. via new catalytic process. Already on stream is automated 25-million-lb./yr. pentaerythritol facility using firm's own process.

Atlantic Research Corp. has firmed up plans for a million-dollar headquarters in Alexandria, Va. The 55,000-sq.-ft. structure will house around 250 employees.

Saran Lined Pipe Co., division of Michigan Pipe Co., has established a new district office in Elizabeth, N. J.

MERGERS & ACQUISITIONS

Sandoz, Inc., has acquired the Fine Colors Co. of Paterson, N. J., manufacturer of pigment colors. Fine Colors will continue to operate unchanged as a division of Sandoz.

Electro-Technical Labs, a division of Mandrel Industries, has acquired North American Geophysical Co. of Houston, Tex.

Panogen, Inc., and Larvacide Products have been merged into a division of Morton Chemical Co. under the name, Panogen Co., Div. of Morton Chemical Co.

Minnesota Rubber Co. has acquired Park Tool Co., a tool and die manufacturing firm in suburban Minneapolis.

Narmco Adhesives & Plastics Co. has purchased all outstanding shares of Santa Barbra Plastics, a developer and manufacturer of vinyl-coated plastics for aircraft, industrial and agricultural uses.

Consolidated Electrodynamics Corp. and Cenco Instruments Corp. are studying plans for a possible merger. Any consolidation agreement would have to be approved later by stockholders.

NEW COMPANIES

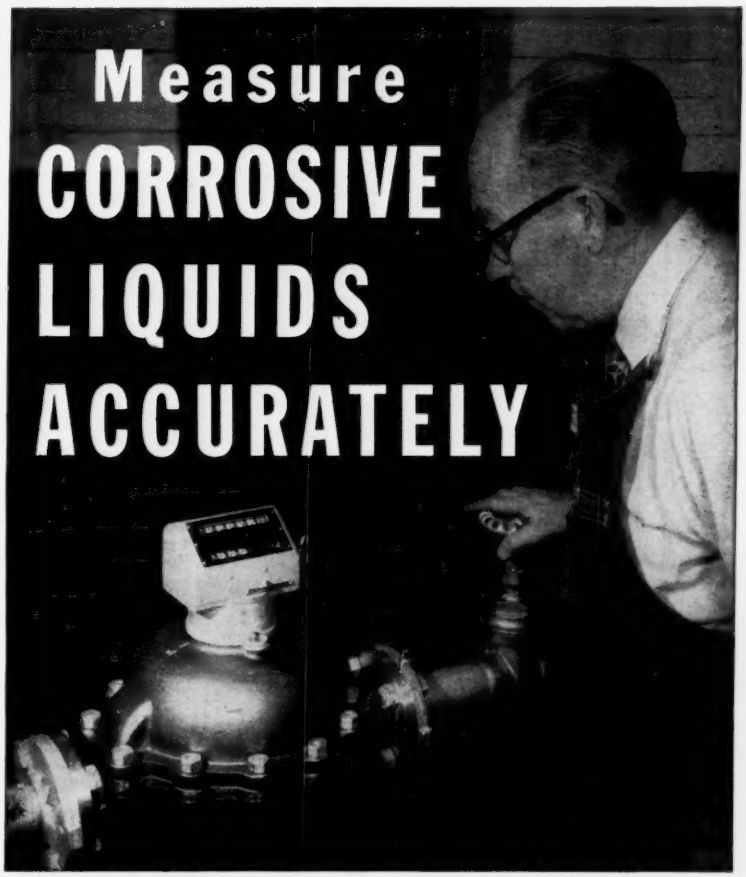
Clyde Williams & Co., Columbus, Ohio, has been formed to provide top industrial management with assistance on broad technical and business problems.

Ethone de Mexico S.A., has been established in Mexico City by American Smelting & Refining Co. to produce and sell the Ethone line of metal finishing products in Mexico.

National Cylinder Gas Co. has organized two new divisions: Chemical Products Div. consolidates several of company's chemical activities. Girdler Construction Div. is now a separate unit designing and building processing plants.

Moore Associates, a new electronics systems manufacturing and development company, has been founded in Redwood City, Calif.

Vickers Chemicals Div. of Vickers Petroleum has been set



with NIAGARA Displacement Meters

Now you can apply the extreme accuracy of Niagara Meters to the measurement of corrosive liquids. Niagara Chemical Meters of Type 316 stainless steel offer good resistance to corrosion and can be used to measure caustic soda, most acids, fruit juices and similar liquids. Available in sizes 3 to 110 G.P.M. or in intermittent use up to 160 G.P.M. Niagara Chemical Meters are also available for automatic liquid measurement and liquid flow control in hazardous or non-hazardous atmospheres.

If you have corrosive liquid metering problems, let us help you. Mail coupon today.

BUFFALO METER CO.

2891 Main Street

BUFFALO 14, NEW YORK

Please send me information on the complete line of Niagara Meters.

Liquid.....

Flow g.p.m..... Temp.....°F

Name.....

Company.....

Address.....

Heating?

Cooling?

Air Conditioning?

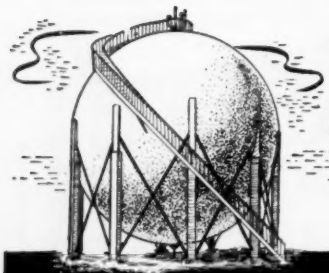
Process?

Here's How to Get the RIGHT Answer to your HEAT-EXCHANGE PROBLEMS

The right ratio of surfaces – the right materials – the right velocities – the right proportion between coil area and depth . . . there are dozens of factors that affect the efficiency, maintenance and service life of heat-exchange coils.

For best performance in your own application, the practical approach is to take full advantage of the unequalled engineering, research and design skill — the unequalled manufacturing and testing facilities — which Aerofin offers you.

To get the *right* answer – ask the Aerofin man.



Throughout the Chemical Industry –

Aerofin units do the job Better, Faster, Cheaper

AEROFIN CORPORATION 101 Greenway Ave. Syracuse 3, N. Y.

Aerofin is sold only by manufacturers of fan-system apparatus. List on request.

FIRMS . . .

up to handle marketing of benzene, toluene and xylene that will come from company's new $2.5-million Udex extraction unit at the Potwin, Kan., refinery.

Hycon Eastern, Inc., has established a Crystal Filter Div., integrating all functions connected with crystal devices.

Morton Chemical Co. now encompasses all manufacturing, sales and research in field of chemicals formerly carried on by parent Morton Salt Co.

Southern Overseas Underwriters has been incorporated to offer insurance and reinsurance for off-shore and onshore oil drilling and production equipment located in Central and South America.

Metrix Corp., Newton, Mass., will manufacture instruments for use with strain gages and strain gage devices and will engineer systems based on these devices.

Allis-Chalmers and RCA have formed a new engineering group, C Stellarator Associates, to design and build a device for advanced research in controlled fusion reactions at Princeton Univ.

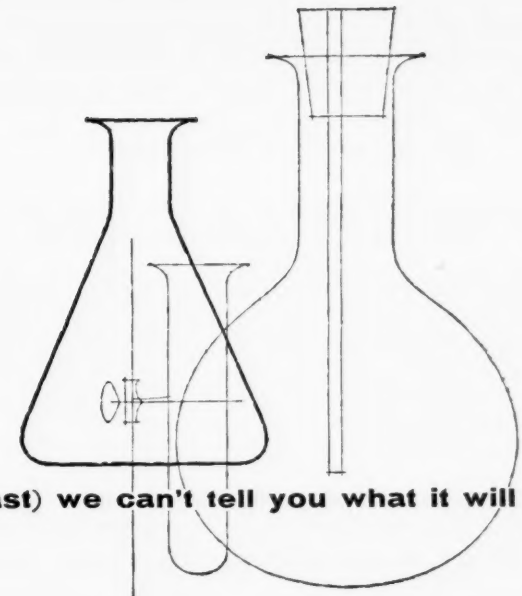
NEW LOCATIONS

Carrier Corp.'s Machinery & Systems Div. has moved into a new district office building at 2727 Weslayan St., Houston 27, Tex.

U. S. Industrial Chemicals' Boston office is being relocated at 150 Causeway St., Boston 14, Mass.

A. W. Cash Co., manufacturer of pressure, temperature, hydraulic and combustion-control equipment, has moved its offices to 115 S. Main St., Decatur, Ill.

what will the **STTM** *do for the chemical industry?*



so new (and so fast) we can't tell you what it will do!

SMITH TURBINE-TYPE MIXER

Perhaps you've heard about it — the phenomenal new Smith Turbine-Type Mixer that's changing performance standards in dozens of industries.

"LIVE MIX" — *an entirely new principle*

Mixing is done in a doughnut-shaped drum. There is no "dead center" area. Blades set up a braiding action which breaks down centrifugal forces. As a result the Smith Turbine-Type Mixer mixes at a peripheral rate of *six hundred feet per minute!* It is truly *motion well directed.*

Regardless of the application, no conventional mixer can even approach the new Smith Turbine-Type in performance: blending is as thorough as it is fast.

Outline your problems... *we'll give you the answers* (based on the almost unbelievable test records of this new mixer in various fields). No obligation.

SMITH

Since 1900, the pioneer designer and foremost manufacturer of the world's finest mixers.

THE T. L. SMITH COMPANY • **Milwaukee, Wisconsin** • **Lufkin, Texas**

Affiliated with Essick Manufacturing Company • *Los Angeles, Calif.*

A8-4044-1P

Inco high-temperature research note:

Effect on heat resistant alloys of the combustion products of Bunker "C" fuel oil

The use of Bunker "C" and other types of residual fuel oils for industrial heating poses a severe high temperature corrosion problem.

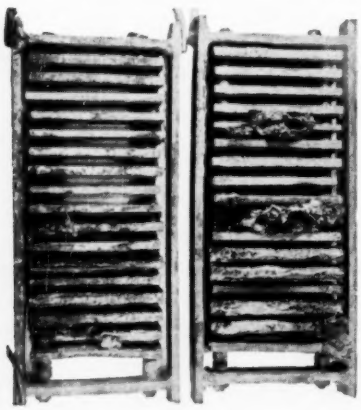
Combustion products from these fuels include a considerable amount of ash containing vanadium pentoxide, sodium and sulfur compounds, which have a low fusion temperature.

When this ash is liquid, it creates a fluxing action on the metals and high corrosion rates follow.

Since long field experience has shown all of the heat resistant alloy to be susceptible to this type of damage, an approach based on the addition of substances to the fuel oil to prevent the ash from becoming molten has been adopted.

Inco High Temperature Engineering Service conducts in-plant tests

Inco engineers—in cooperation with several Steam Power and Stationary Gas Turbine companies have conducted a series of in-plant tests in order to determine the behavior of certain high temperature alloys when exposed to Bunker "C" burned with or without additives.



Test racks after exposure

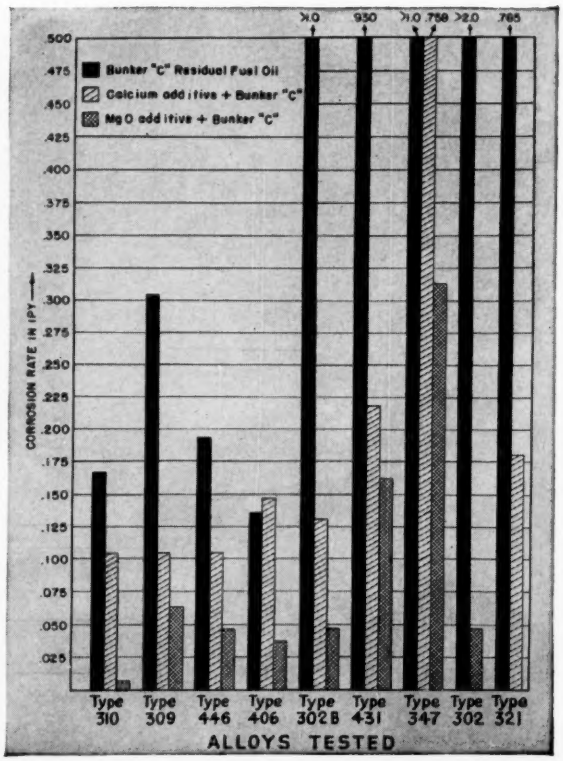
Each rack carried many specimens of different compositions, all precisely measured before installation. Corrosion rates are developed from these specimens by metallographic examination.

Corrosion results were obtained on both cast and wrought alloys as well as on some alloys with various coatings. The bar graph (below) shows the results of nine of the alloys tested. (Note for example, the performance of type 310 under the severe vanadium, sodium and sulfur environment.)

In general, data derived from this Inco High Temperature test points up the benefits of using additives when burning Bunker "C" fuel oil. It also provides a basis for material selection in terms of cost and length of service.

Inco has investigated many metals and alloys under hundreds of high temperature environments. If you have a metal problem involving high temperature performance let us help you. Send for our High Temperature Work Sheet . . . a form that makes it easy for you to outline your problem to us.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

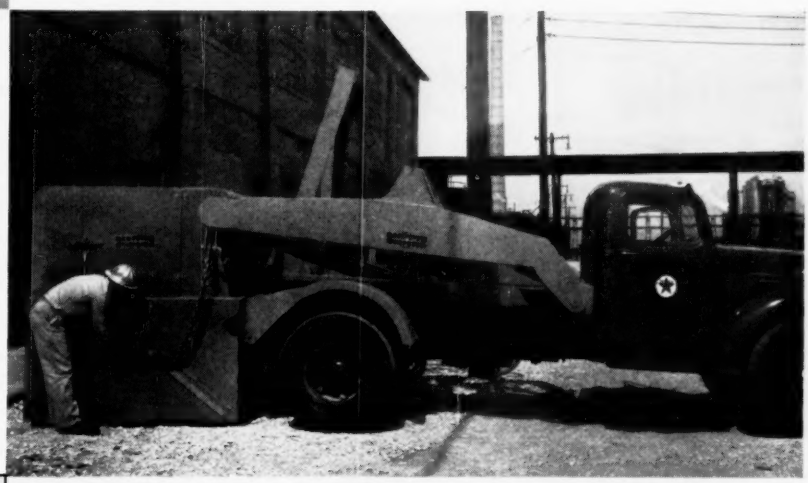


TEXACO

REG. T.M.

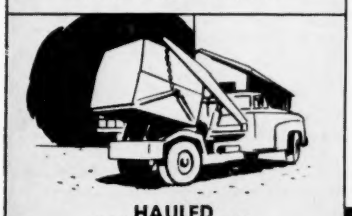
The TEXAS COMPANY "CONTAINERIZES" Waste as it Accumulates

Port Arthur Refinery "Containerizes" Waste, Rubbish and Liquids at Many Accumulation Points . . . Hauls and Dumps Them With Dempster-Dumpsters



WASTE IS CONTAINERIZED . . .

. . . PICKED UP . . .



. . . HAULED . . .

. . . AND DUMPED . . .

Dempster-Dumpster Waste Disposal System Serves Leading Refineries & Chemical Plants

Waste disposal and plant cleanliness can no longer be efficiently maintained by wheelbarrows, cans, carts, or bins. Shoveling, re-handling and on-site dumping have been replaced in leading plants by "Containerization" of waste as it accumulates. By placing clean, big-capacity Dempster-Dumpster containers at accumulation points, you can save thousands of dollars annually and enjoy improved plant cleanliness.

The one-man, one-truck Dempster-Dumpster can service over a hundred accumulation points, picking up, hauling and emptying the containers on a planned shuttle schedule. Chemical plants and refineries customarily amortize their equipment investments in 18 months or less. Write today for the free booklet, below.

FREE: Write Today for Your Copy of
"How to Reduce Waste Disposal Costs."

DEMPSTER BROTHERS, Knoxville 17, Tenn., DEPT. CE-3

THE DEMPSTER DUMPSTER® SYSTEM

To: Dempster Brothers, Dept. CE-3
Knoxville, Tennessee

Please Send Without Obligation Your Booklet, "How to Reduce Waste Disposal Costs."

NAME..... TITLE.....

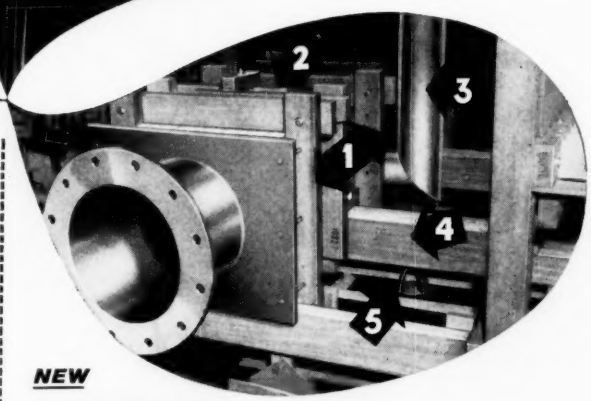
COMPANY.....

ADDRESS.....

CITY..... STATE.....

Pritchard

INDUSTRIAL
COOLING TOWERS
HAVE NEW FEATURES
FOR BETTER
PERFORMANCE . . .
EASIER
MAINTENANCE



NEW
DRIFT ELIMINATORS

The NEW drift eliminators in Pritchard counterflow cooling towers are supported from the framework for ease of erection and the slip-fit blades are easily removable for access to the laterals of the distribution system as illustrated. The drift eliminator sections over the main distribution header are removable in prefabricated units for quick servicing. These NEW eliminators are a full 6-feet below the fan deck, providing a fan plenum chamber, with ample head room for easy servicing and inspection.

WRITE TODAY FOR FREE BROCHURE

Between the covers of "Answers to the 15 Questions About Pritchard Induced Draft Cooling Towers," you will find a wealth of helpful information. Information that will assist you in selecting your cooling tower. Write today on your company letterhead for your FREE copy. No obligation, of course.

NEW
DISTRIBUTION SYSTEM

The Pritchard tower employs the closed All Heart Redwood distribution system providing better water distribution and trouble-free performance. To this time tested system have been added several NEW features:

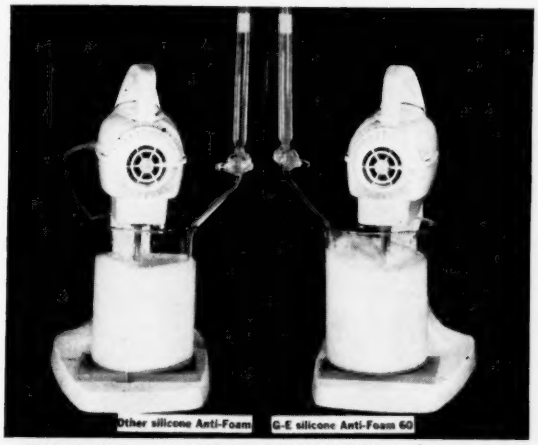
1. NEW Main Header . . . made of 1½" T&G with splined joints between panels for leak-proof construction.
2. NEW Top Cover . . . panel is easily removed for inspection or clean-out.
3. NEW Relief Vent . . . stand-pipe prevents damage from overpumping and eliminates danger of blowing out header.
4. NEW Laterals . . . of simplified construction with splined joints. Each lateral has easy-to-remove end plug for fast, easy flushing.
5. NEW Non-Clogging Distributors . . . made in one piece to assure steady, even flow of water over tower fill.

INDUSTRY'S PARTNER FOR PROGRE

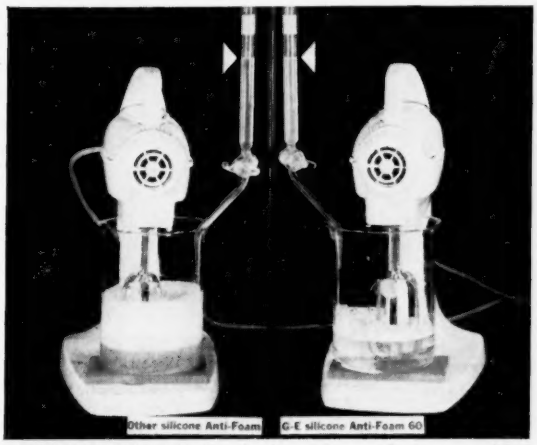
COOLING TOWERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 577, 4625 Roanoke Parkway, Kansas City 12, Mo.



TWO IDENTICAL DETERGENT SOLUTIONS are beaten for 10 minutes at the same speed. Left burette contains dilute solution (0.1% silicone solids) of other leading silicone anti-foam. Right burette contains similar solution (0.1% silicone solids) of G-E Anti-Foam 60.



EQUAL QUANTITIES (3 cc) of anti-foam solution are added to each beaker, sufficient to kill initial foam in both beakers. When beating is resumed for 5 minutes, heavy foam again forms in beaker containing anti-foam "X" (left), but not in beaker with G-E AF-60.

FOAM IS COMPLETELY DESTROYED by adding anti-foam to each beaker until it is impossible to restore any foam by continued beating. This takes 5.8 cc of anti-foam "X", only 3.9 cc of G-E AF-60.

30% Less Silicone Anti-Foam Needed When You Specify General Electric AF-60

The test at left, of course, only proves the superior economy of General Electric AF-60 in one foaming system. But it is typical of the success being reported for AF-60 in many aqueous systems.

The best test for you is to try G-E AF-60 in your own operations. You'll find it disperses faster than any other silicone anti-foam, yet G-E AF-60 comes to you in a higher concentration to reduce inventory and storage costs. We'll be glad to send you a free sample if you mail the coupon below. General Electric silicone fluids and compounds are also available for efficient low-cost defoaming of non-aqueous solutions.

GENERAL ELECTRIC

SILICONE PRODUCTS DEPARTMENT,
WATERFORD, NEW YORK

MAIL THIS COUPON FOR A FREE SAMPLE . . .

Section A3E3, Silicone Products Department
General Electric Company, Waterford, New York

Please send me a sample of G-E Anti-Foam for

☐ aqueous system ☐ non-aqueous system

Application_____

Name_____ **Position**_____

Company_____

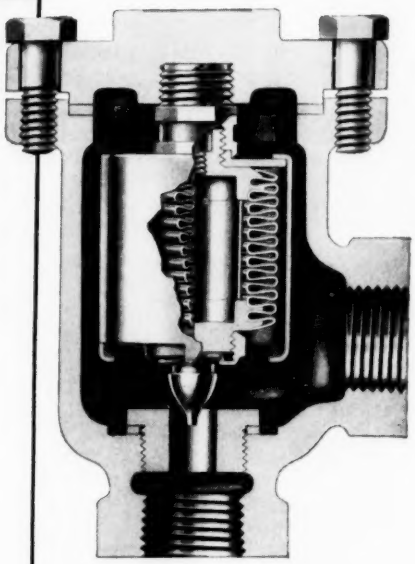
Street_____

City_____ **Zone**____ **State**_____

Proven by performance!

All departments agree on operating efficiency of SARCO Thermostatic Steam Trap

	MAINTENANCE	PURCHASING	STORES
1. **Same head and seat for 0-300 psi** — no changing of heads and seats for varying loads and pressures.	✓	✓	✓
2. **Fewer parts to stock** — same bellows, head and seat for 0-300 psi.		✓	✓
3. **Greatest capacity per dollar cost** — 1" size discharges 9,650 lbs/hr at 10°F below steam temperature, 125 psi.		✓	
4. **Very compact and light** — ¾" size fits in palm of the hand. Weighs only 3¾ lbs.	✓		
5. **Freeze-proof**—wide open, self-draining when cold.	✓		
6. **Only one working part** — the thermostatic element. Can be inspected or replaced in few minutes without moving trap from line.	✓		



SARCO

Balanced Pressure

THERMOSTATIC STEAM TRAP

Same seat and head
for all pressures to 300 psi

•

Sizes ½" to 2"

•

Write for Bulletin 250

Proven by testing!

Steam-tested — every single Sarco Thermostatic is steam-tested at rated maximum pressure.

Proven "on-the-job" performance — maximum fatigue-resistance for every thermostatic element is assured by Sarco's exclusive helical corrugating process and fatigue testing method.

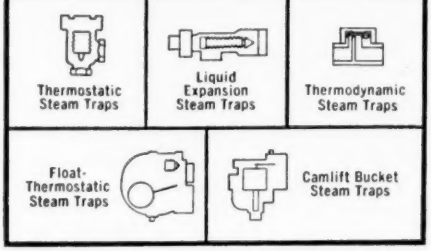
Quality Control — every step of manufacture under exacting tests and controls . . . in Sarco's own plant.

Proven by experience!

During past 40 years, over 1,000,000 Sarco Thermostatics have been installed in countries throughout the world!

Only Sarco Makes All 5 Types

. . . that's why Sarco can give impartial advice on trap selection

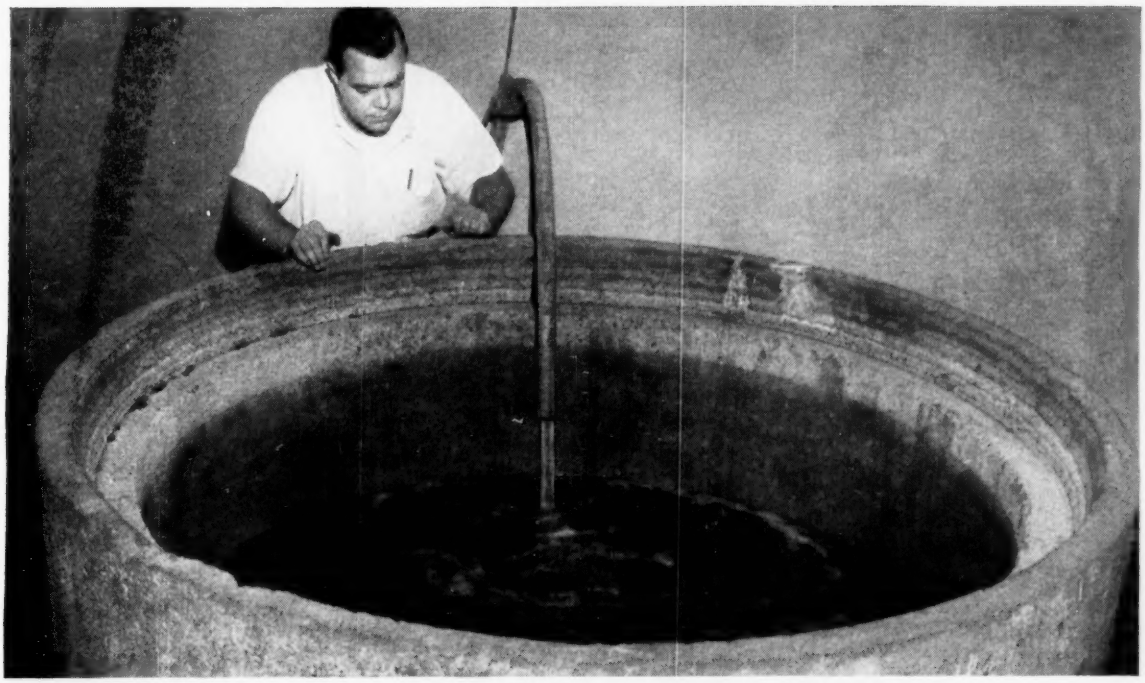


Sarco Company, Inc., 635 Madison Avenue, New York 22, N. Y.

AN AFFILIATE OF SARCOTHERM CONTROLS, INC.

2212-B

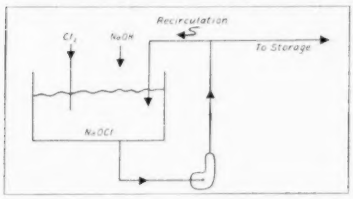
STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES



HYPALON hose, in continuous use since May, 1954, recirculates bleach solution (diagram) and transfers it to storage vat shown above.

HYPALON® hose cuts bleach plant replacement costs

John Wiley Jones Company of Charlotte, North Carolina, manufactures bleach for laundries, paper mills and textile houses. In the manufacturing process, sodium hydroxide, 26° Baumé is pumped into vats, chlorine is added, and the blending of the two



chemicals produces sodium hypochlorite. HYPALON hose is used to recirculate the solution during production and to transfer the bleach to storage.

The hose is used intermittently 8 hours a day, 6 days a week, and is immersed in the vats to prevent spray and spilling. Pressure is about 20 psi, and temperature range is 40-100° F. Ordinary rubber hose, used previously, had to be replaced every few months because bits of rubber, shredded from the hose by chemical attack, contaminated the bleach.

John Wiley Jones Co. started using the HYPALON hose in May, 1954. Since then it has been in continuous use without contaminating the bleach. There have been no maintenance or replacement costs since its installation.

In service such as this, HYPALON's balanced combination of properties pays off in long service, less maintenance. Although usually referred to as acid hose, HYPALON hose might be better termed "chemical hose." It has proven effective for both alkaline and acid service, particularly where strong oxidizing agents are encountered.

In addition, Du Pont HYPALON synthetic rubber is resistant to heat (250-350° F.), ozone, abrasion, flex cracking and weathering. It is used in a wide variety of applications where conditions are severe. Tank linings, gaskets, protective clothing are examples. Mail the coupon below for more information on HYPALON . . . and neoprene, the synthetic rubber made by Du Pont for over 25 years.

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc).*

ELASTOMERS IN ACTION HYPALON® • NEOPRENE

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Better Things for Better Living . . . through Chemistry

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☐ Send me a free copy of *The Du Pont Elastomers* (a review of properties of neoprene and HYPALON).

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Elastomer Chemicals Dept. CE-3
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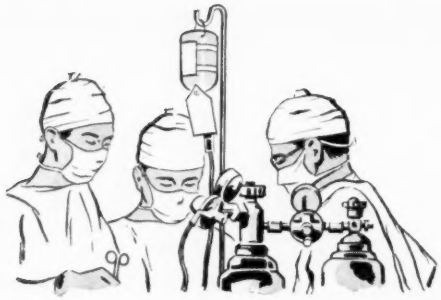
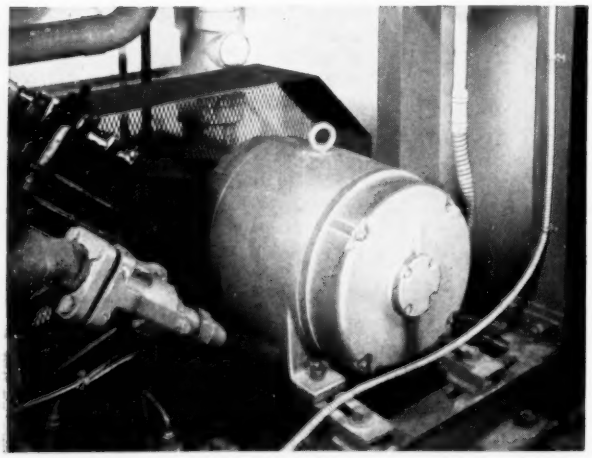
City _____ State _____



Blood Banks must *NEVER FAIL...*

Vital refrigeration units in St. Louis Blood Bank are powered by Wagner Motors



This 30 horsepower Wagner high torque, open type motor drives the refrigeration unit for the blood storage room in the St. Louis Blood Bank.

Wherever there is a motor application of a critical nature—even vital to life itself—Wagner Motors can be relied upon to fulfill their responsibility of completely dependable operation. In St. Louis' Blood Bank, for example, you'll find many Wagner Motors at work—driving the all important refrigeration units that keep the blood at proper storage temperature, that operate air conditioning compressors, that move heated and cooled air to keep the building comfortable in winter and summer.

Whether your motor application is vital to life or not, you can depend on Wagner Motors for efficient, reliable operation.

The complete line includes motors from ½ to 600 hp, singlephase or polyphase, in a wide variety of enclosure types and mountings. Let your nearby Wagner Sales Engineer help you select the right motors for your needs. Call the nearest of our 32 branch offices, or write direct.

Support your Local Blood Program by donating blood *regularly!*

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

WM57-10

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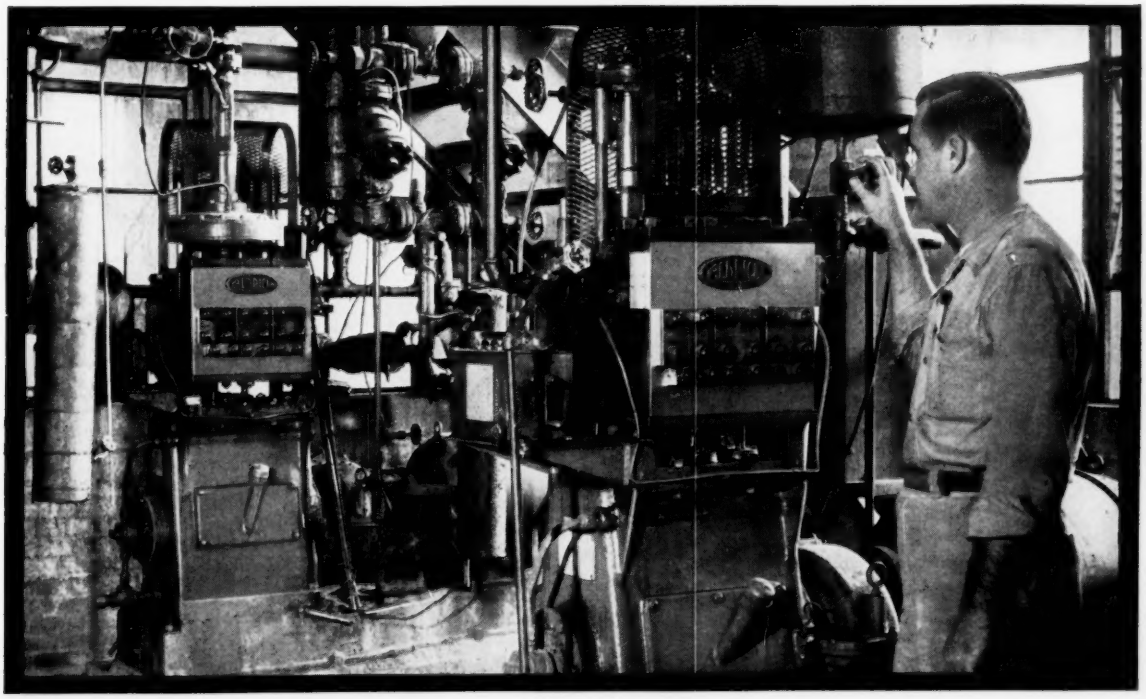
Wagner Electric Corporation
6407 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

EMERY INDUSTRIES LICKS TOUGH PROBLEM:

How to pump fatty acids 24 hours a day, 7 days a week, and cut maintenance costs!

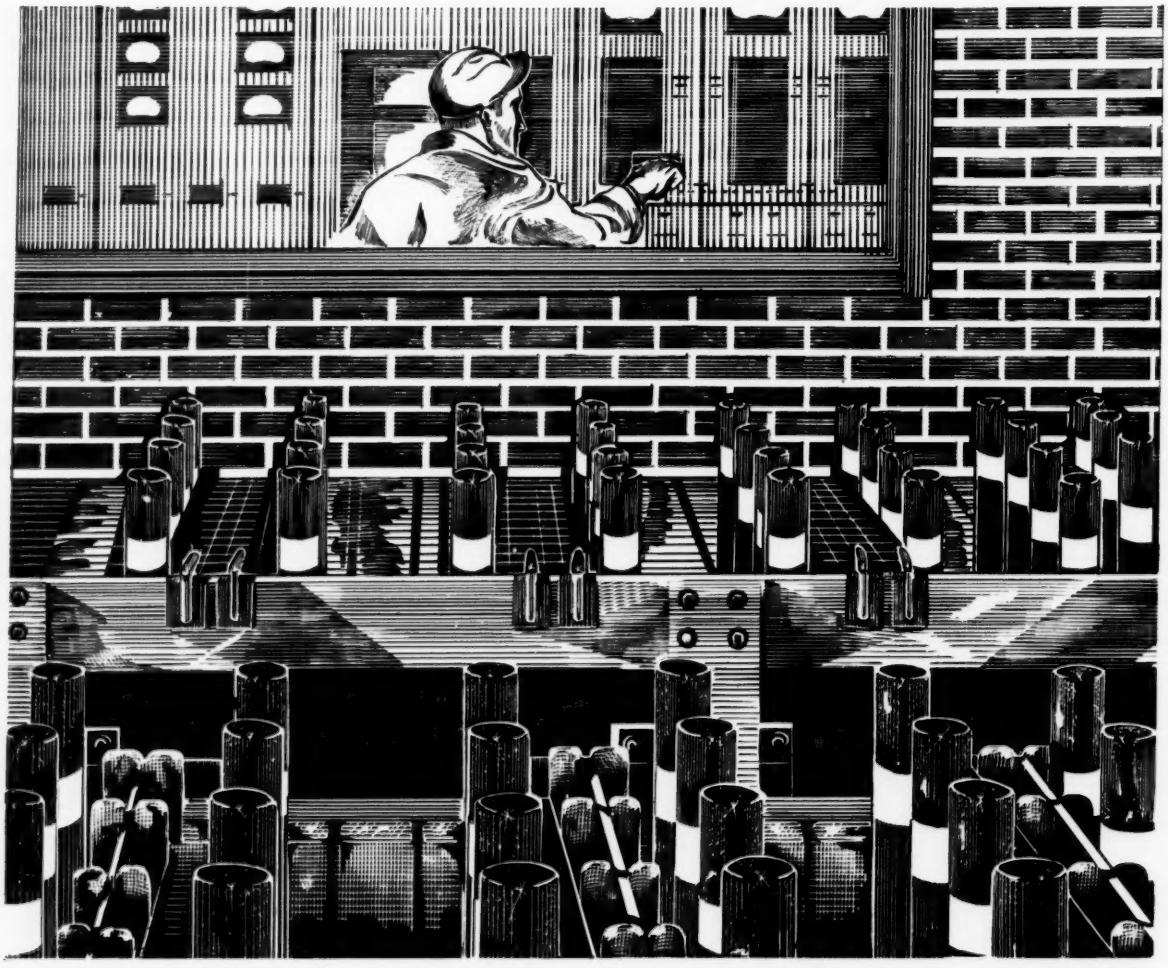
Around-the-clock hydrolysis produces fatty acids from animal fats, tallow, palm, soybean, cottonseed and corn oils at Emery Industries plant in Cincinnati, Ohio. Pumps work on hot corrosive fatty materials 24 hours a day, seven days a week, and maintenance used to be a costly problem. Packings had to be replaced far too often. Valves needed frequent refacing. Wear of plungers was excessive.



How Emery solved the puzzle: Looking for an answer to the problem of excessive downtime and maintenance, Emery conferred with several pump manufacturers. Aldrich was the only company to offer a pump better in both design and materials . . . the fluid end being of stainless steel. Original, ineffective pumps were immediately replaced with Aldrich Triplex Pumps.

Result: Two Aldrich Pumps have pumped raw materials on a continuous basis since 1948. Two more were installed for additional capacity in 1954. Maintenance costs have been reduced substantially. Downtime has decreased to a minimum. Operating efficiency is now at an all-time high and quality of processing has improved. We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH



Better cell operations

The technical skills and experienced know-how of the men who operate mercury cells, are most important factors in low cost chlorine-caustic production.

Equally important is the superior performance of GLC anodes, which are "custom made" to individual cell requirements.

FREE—*This illustration of cell building has been handsomely reproduced with no advertising text. We will be pleased to send you one of these reproductions with our compliments. Simply write to Dept.* **N-3.**

ELECTRODE GLC® DIVISION

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. OFFICES IN PRINCIPAL CITIES

Here's a vertical turbine with

TERRY SOLID WHEEL

and all its advantages

When it comes to judging a turbine's ability to deliver in vertical service, ratings tell only half the story. It's the Terry construction refinements that give you assurance of long-range operational economy: Thrust bearing designed to absorb external pump thrusts ... carbon ring glands specially made for vertical operation ... casings and bearing housings split vertically for easy accessibility.

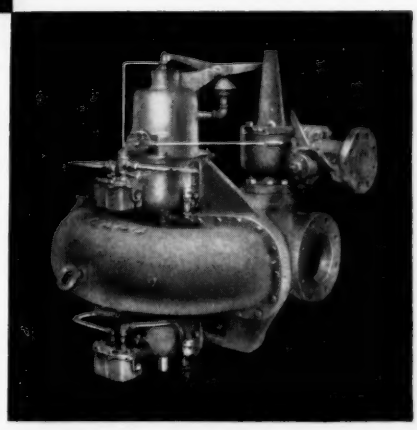
But most important, the Terry vertical turbine has an *almost* indestructible rotor. A single forging of special composition steel, it has no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

If your application demands a vertical turbine, specify Terry solid wheel. Available in capacities from 5 to 300 horsepower. And remember, the extra durability built into these vertical turbines is typical of every turbine in the complete Terry line.

For further information, send for a copy of bulletin S-137.

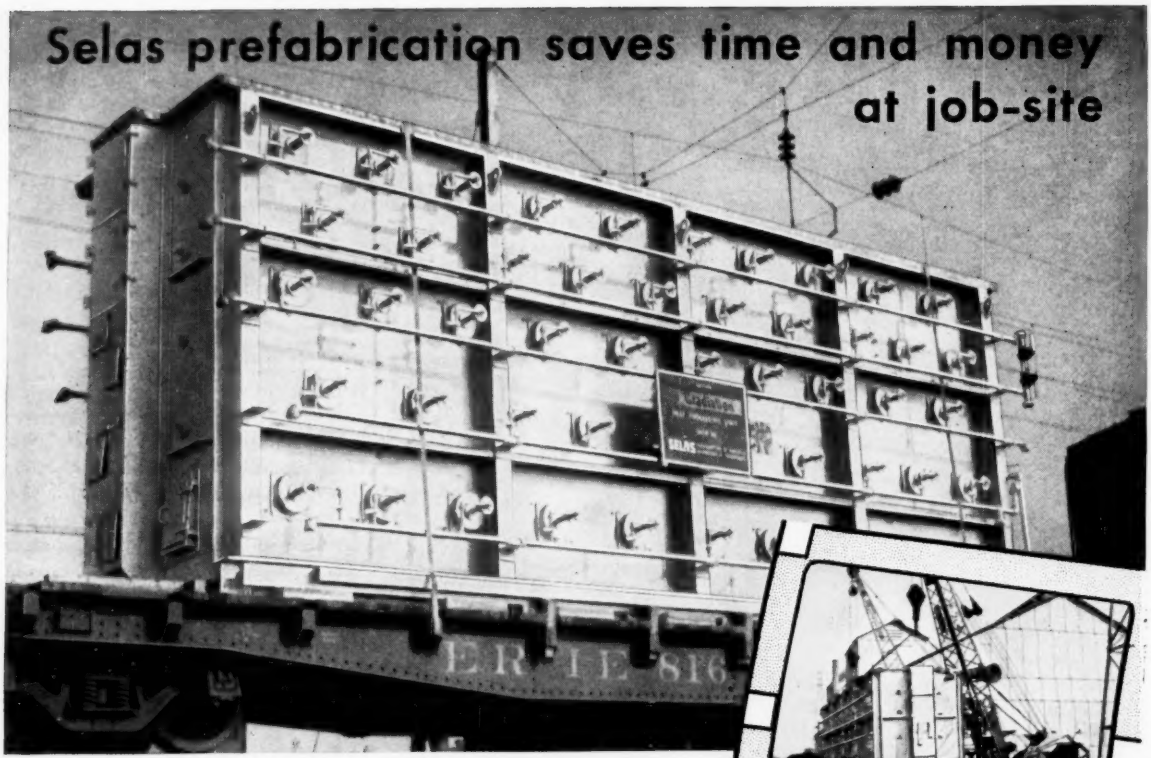
THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

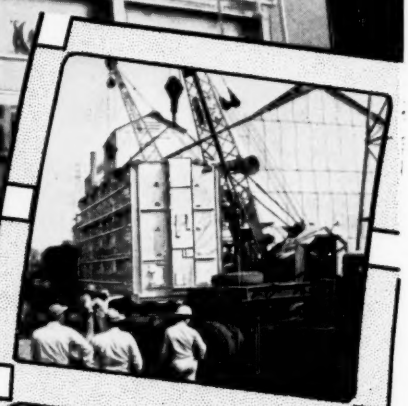


TT-1210

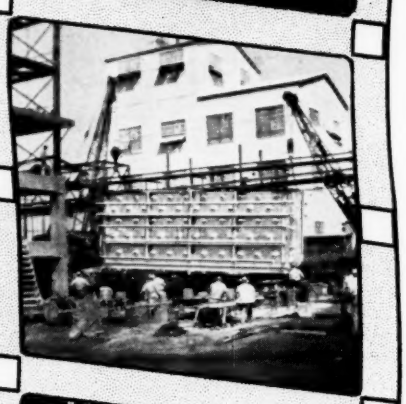
Selas prefabrication saves time and money at job-site



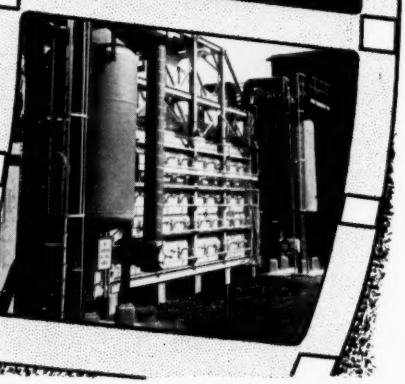
After final inspection, the completed Selas Gradiation Heater is securely anchored on flatcar for shipment. Stack and convection sections are in adjoining car.



Upon arrival at job-site, cranes allow flatcar to be slipped out, Lo Boy slipped in.



The heater is lowered onto prepared foundations.



Convection, and stack sections are installed; connection to process and fuel gas piping completes job.

SELAS prefabrication means much more than the accepted definition of prefabrication: it is *shop-assembly*. In capacities as large as 45 million Btu/hr coil duty, Selas Gradiation® Heaters are *complete* when they are shipped out: burners, brickwork, arch tiles are in place; manifold piping is attached and intact, complete with flanged connections; stacks and ducts completely insulated. Heating coils can be shipped installed or delivered to job-site, pre-assembled on tube supports, as desired.

In terms of field effort, Selas *shop-assembly* means complete erection of sub-assemblies on job-site foundations in less than eight hours!

Whatever your needs—*shop-assembly* or field-assembly—Selas Gradiation Heaters will give you longer "on-stream" periods, high conversions and selectivity, Zone Control of heat input, uniform heat distribution on the entire tube surface which extends tube life. Send for Bulletin 143 "Gradiation Heating for Petroleum and Chemical Processing."

Gradiation is a registered trade name of Selas Corporation of America.

SELAS
CORPORATION OF AMERICA

DRESHER, PENNSYLVANIA
HEAT AND FLUID PROCESSING ENGINEERS
DEVELOPMENT . . . DESIGN . . . CONSTRUCTION

Sam Spinner's Mail Box

by Sam Spinner

Case #1: How can we dry several large bulky items at one time?

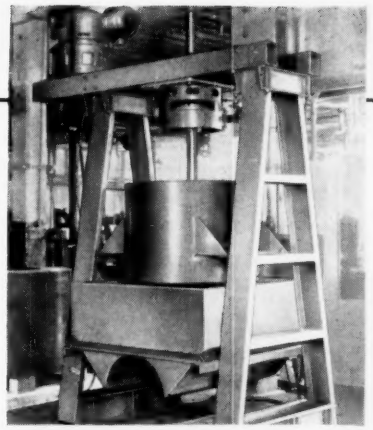
Solution: A T & M Engineers developed a huge Link Type Extractor which would handle loads of several thousand pounds, and also keep power requirements to a minimum.

Case #2: Our Parts Production Line has a bottleneck. Due to the shape of some of our parts, we are unable to handle or unload them in a conventional parts drier. What can you do for us?

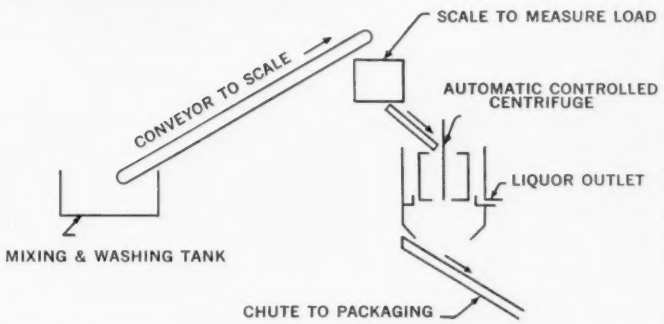
Solution: A Bottom Discharge Machine was developed which not only handles the troublesome parts, but also makes it possible to control entire operation automatically.

Case #3: We have a problem of throwing off excess coating after a hot dip, and are unable to clean unit as easily and fast as we require.

Solution: A special machine was developed to give extra fast acceleration to remove excess coating before solidification. Housing unit was made to open wide to facilitate cleaning in a very short period.



FLOW CHART shows automatic handling of bulk solids in an AT&M centrifugal. Solids are treated more gently than when operators did the material handling.



Solids separated gently ... and automatically

Many "special" chemical processing problems find *the one best answer* in centrifuging engineered by AT & M experts.

Here liquids are to be separated from the solids . . . but the solids must be treated gently. AT & M engineered this machine that handles the products without the use of bags. It carefully loads into the basket through AT & M's slow-speed loading drive. After extraction, the basket is unloaded onto a conveyor by a new type bottom discharge basket without the use of a plow. The whole cycle is performed automatically without need of an attendant.

New AT & M models make maximum use of time and space, with top safety. Send coupon for data.

AMERICAN TOOL & MACHINE COMPANY
1415 Hyde Park Ave., Boston 36, Mass.

Please send me my free copy of the new AT&M booklet "Centrifugal Force." I am interested in the following processes:

Separation ☐ Extraction ☐ Dehydration ☐ Clarification ☐
Coating ☐ Filtration ☐ Draining ☐ Thickening ☐ Impregnation ☐
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SAVE TIME, SPACE AND COSTS WITH

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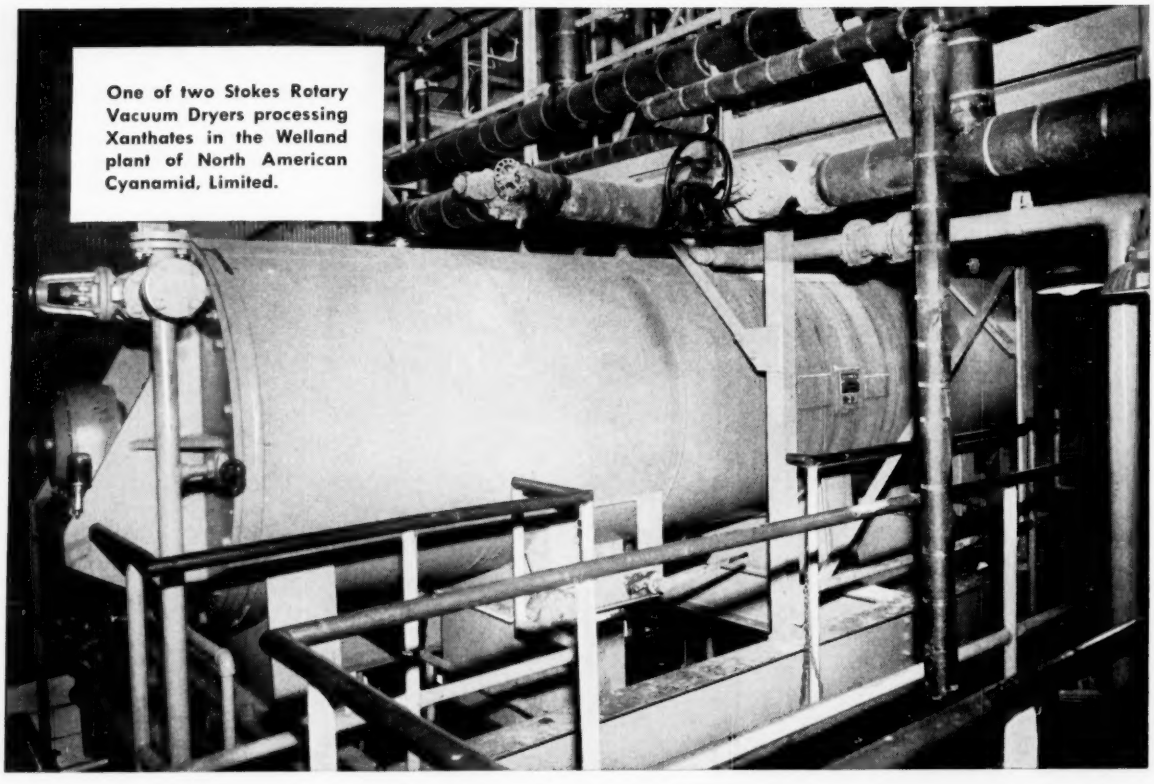

One of two Stokes Rotary Vacuum Dryers processing Xanthates in the Welland plant of North American Cyanamid, Limited.

Stokes Rotary Vacuum Dryers process Xanthates for North American Cyanamid, Ltd.

North American Cyanamid's Welland plant, near Niagara Falls, Ont., is the only Canadian producer of Xanthates . . . a series of materials used in mining and mineral industries as flotation reagents. Stokes Rotary Vacuum Dryers play an important part in the production of these heat and air sensitive materials.

The standard "extra" features of these dryers give continuous operation that means no maintenance shutdowns—process uniformity that means more pounds of saleable products—and operating efficiency that means more profit.

- Continuous double-spiral agitators . . . fast, uniform drying . . . easy unloading . . . low power requirements.
- Heated agitator shaft and arms . . . up to 25% greater heat transfer.
- Self-aligning, tapered roller bearings . . . low power requirements . . . less stuffing box wear.
- Plug-type, flush discharge door . . . no undried pockets . . . rapid unloading.
- Process-proved options, selected according to your product requirements . . . spring loaded scrapers . . . heated or unheated, conventional or inverted dust filters . . . special construction materials . . . fixed or variable speed drums.

Stokes produces rotary vacuum dryers, rotating vacuum dryers, vacuum shelf dryers, drum dryers and flakers, tabletting equipment . . . maintains a complete laboratory to provide expert application assistance. Write Stokes, or contact your nearest Stokes office for complete information.

Vacuum Equipment Division
F. J. STOKES CORPORATION
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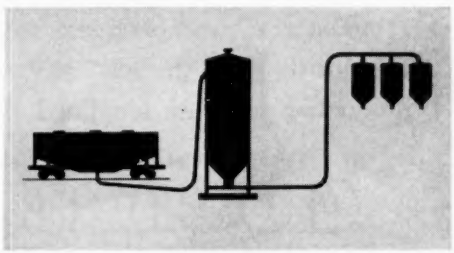
GOT TONS OF RESINS AND PLASTICS TO MOVE?

FULLER will do it better with air

Fuller offers you over 30 years of experience in designing and building pneumatic conveying systems for dry bulk materials . . . Fuller-Kinyon, Fuller-Fluxo, Airveyor® and F-H Airslide®.

Whether it's a comparatively simple operation of unloading a few tons of material an hour from car to storage, or the more complicated, automatic, remote-controlled in-plant system, or it can be tailored to your plant's requirements.

You too will find, as thousands of others have, that it is good economy to install Fuller pneumatic conveying systems for top sustained production at lowest operating costs. It will permit you to take full advantage of savings inherent in handling materials in bulk.



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When is a bargain not a bargain?

If your supplier neglects any one of nine important steps in the production of stainless steel plate his product may not be a bargain for you.

The wise buyer of stainless steel plate and plate products insists upon the solid service and sound methods of production that are identified with G. O. Carlson, Inc.

- Composition of each melt rigidly controlled to come well within the specification; with carbon always reported to the third decimal.
- Adequate trimming of both the hot top and butt end after the slab is rolled to guarantee sound material.
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- Rigid inspection of work throughout entire production cycle.
- Prompt, on-time delivery to maintain your production schedules.

G.O.CARLSON Inc.

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For Fast "On and Off" — or Continual Use

NEW AO POCKET RESPIRATOR

This recent addition to American Optical's full line of engineered respirators has proved very popular from the outset. It fills a real need! Workers stepping from non-hazardous to questionable or hazardous areas and vice versa can whip it on and off intermittently. Or it can be worn for extended periods. There are sixteen filter cartridges used in this respirator which protect against a variety of dusts, mists, fumes, vapors and gases. Your nearest AO Safety Products Representative can supply you.

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- COMPACT — ONLY 3" x 3" x 2¼".
- LIGHTWEIGHT — ONLY 4 OUNCES.
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How your truth dollars help keep the Reds in the red

• The truth dollars you give to Radio Free Europe help keep truth on the air behind the Iron Curtain.

And the truth is an enormously disruptive force to the Reds. For it keeps their captive people thinking . . . wondering . . . and less than completely dominated. The truth keeps needling the Reds. Breaks through their monopoly of lies. Keeps them unsure. Off balance. And thus the truth keeps up to forty fully armed Red divisions tied up policing Russia's satellite countries. Forty divisions, mind you, that might otherwise be put to more aggressive use elsewhere . . . and who knows where?

Your truth dollars keep the 29 super-powered transmitters of the Radio Free Europe network on the air . . . broadcasting the truth behind the Iron Curtain . . . every hour of every day.

Why *your* truth dollars?

Because Radio Free Europe is a private, non-profit organization supported by the voluntary contributions of American business and the American people. And *your* dollars are urgently needed to keep it on the air . . . to help operate its transmitters, pay for its equipment and supplies, and its scores of announcers and news analysts in 5 languages.

Help keep the Reds in the red. Send your truth dollars to Crusade for Freedom, care of your local postmaster.

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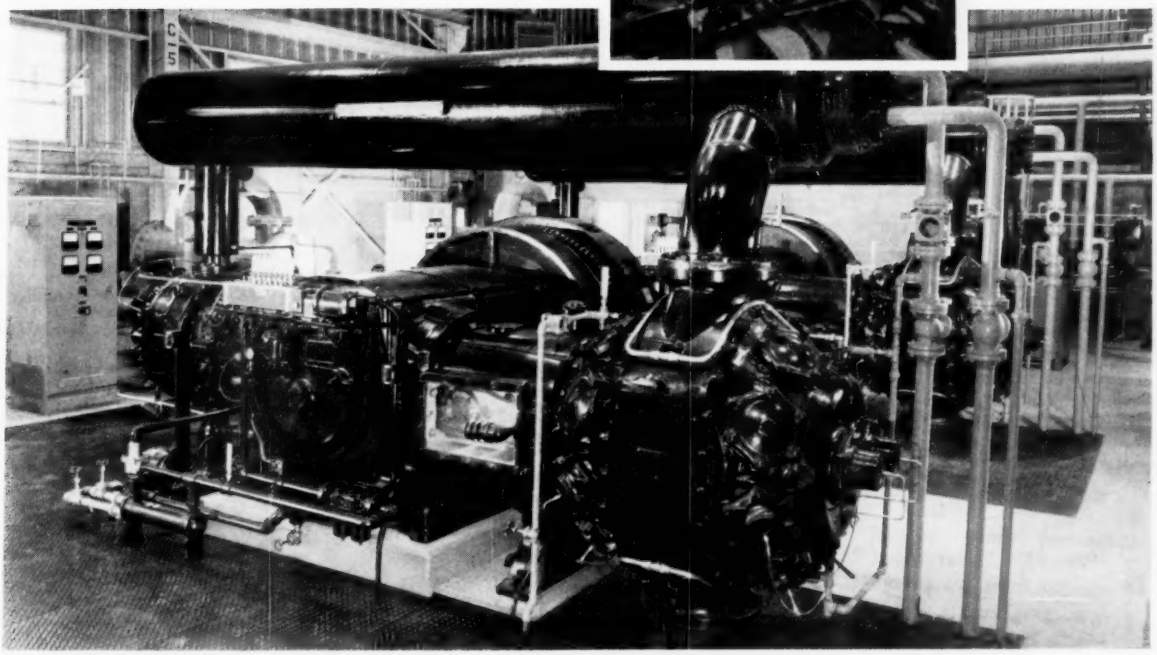
NATURAL BALANCE...

for smoother compressor performance



In Cooper-Bessemer industrial air compressors, just as in nature, forces oppose forces, resulting in the smoothest compressor performance imaginable. So we call it Natural Force Balance . . . and it has a lot of bearing on compact design, continuous availability, and prolonged low cost of shop air supply!

If you plan on new or expanded plant air facilities, by all means send for new Bulletin M-81, "Air for Industry". It covers Cooper-Bessemer M-Line compressors, 200 to 10,000 hp, and tells you about the advantageous *new* things being done by one of America's *oldest* engine and compressor builders.

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ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE OR MOTOR DRIVEN

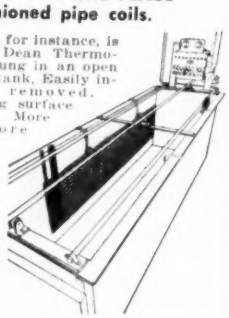
GRANDPA USED PIPE COILS

HE NEVER SAW A

DEAN THERMO-PANEL COIL

which now TAKES THE PLACE of old-fashioned pipe coils.

At the right, for instance, is a Standard Dean Thermo-Panel Coil hung in an open rectangular tank. Easily installed and removed. More heating surface per sq. ft. More efficient. More economical.



See the Dean Curved Thermo-Panel Coil below. Superior to old-style coils in every way.

BULLETINS

Bulletin 355 contains 52 pages of valuable Technical Data. Bulletin 258 gives prices and design data enabling you to do your own estimating and designing. If you need help, call on Dean Specialists.

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for any liquid
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193 All items discussed
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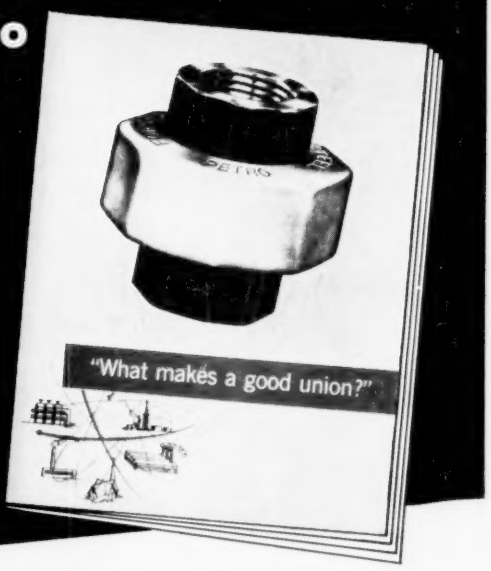

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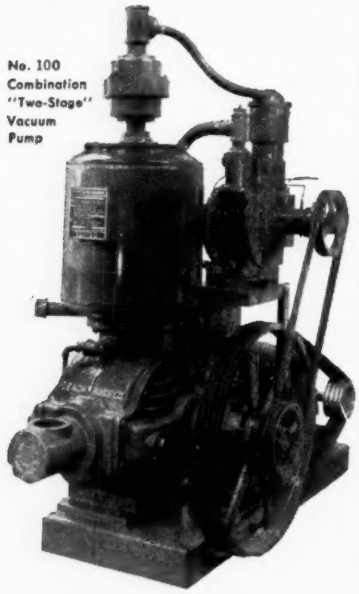

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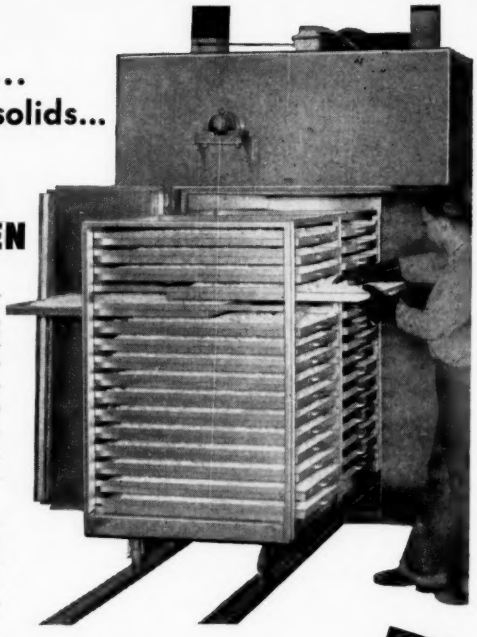

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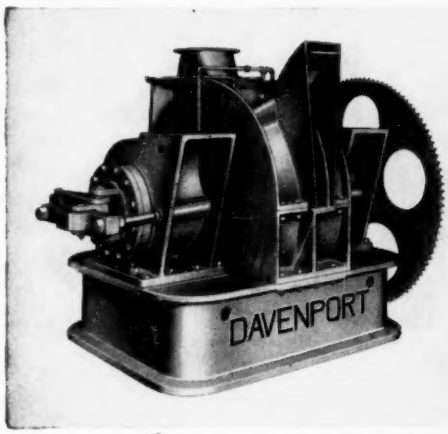

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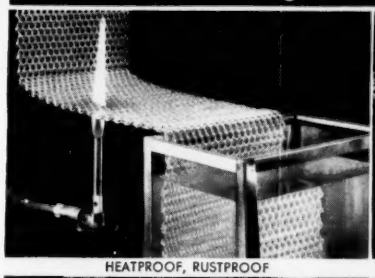
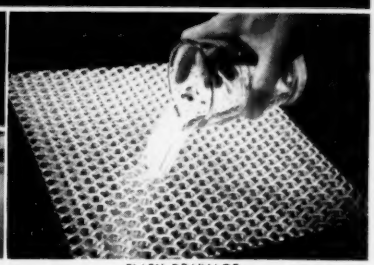


HEATPROOF, RUSTPROOF



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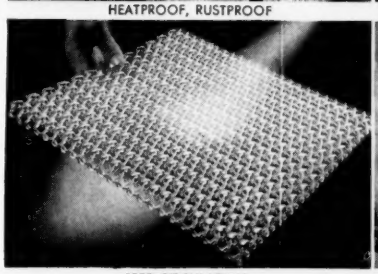

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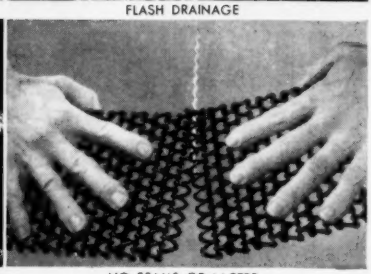

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How Research Shapes Our Future Prosperity

If you are looking for an industry that is going to keep on booming in 1958 and every year for the next decade, here it is. It is the industry of technological innovation through research and development.

Last year this great new industry spent over $7 billion to discover and develop new industrial products, processes and equipment. This year the preliminary McGraw-Hill survey indicates that total expenditures for industrial research and development will be even greater, perhaps as much as $8 billion. Of the companies surveyed, 57% plan to spend as much as in 1957 and 38% plan to spend more.

The sustained expansion in research and development is the best guarantee we have that the current decline in business investment in new plants and equipment will be relatively short-lived. There can be no prolonged decline in investment in an economy where technology is changing rapidly.

This editorial is designed to show how the continued surge in research and development can be expected to lead first to new products, and eventually to renewed expansion of investment in new industrial plants and equipment. Such expansion is the essence of national economic growth.

A Slow Start

The impact of research on sales and investment is still very gradual. Research spending itself has more than doubled in the last four years. But only 32% of all manufacturing firms report significant capital outlays to make new products. We are not reaping the full dividends of industrial research as yet for several reasons:

- Research expenditures were relatively small until the Korean War of 1950 brought substantial government contracts in aviation, electronic and related fields. Heavy research outlays for civilian and industrial products came even later.

- There is an average *lag*, according to research directors consulted by the McGraw-Hill Department of Economics, of roughly seven years from the start of research until the product is ready for large scale output — about five years of research and at least two years to solve production problems and develop markets.

- Complex products, such as new consumer durables and industrial machinery, have an even longer time lag.

However, new developments are certainly underway. Research began to increase in all lines of business when Korean War restrictions and

the excess profits tax came to an end in 1953. The tax revision of 1954 added a new incentive by making research outlays deductible as a current business expense. By 1955, the research boom was on.

When Is The Payoff?

With a lag of about seven years, it will be the early 1960s before these new developments become a dominant factor in capital investment. But once the flow of new products and new processes starts, it will accelerate sharply — just as research spending has accelerated in the past few years.

By 1960, over $50 billion in sales will be coming from products not on the market as recently as 1956. Sales of new products will increase year by year, but they will gain most in 1960-1962, or five years after the recent spurt in research expenditures.

Capital expenditures to manufacture new products will also rise, but with a slightly longer lag. Here the sharpest rise should come in 1962-1965, as the new products reach a volume that calls for a significant amount of new capacity. In most cases, initial output of new products will come from existing capacity.

This timing of a new wave in capital investment appears logical on other grounds. Population experts forecast an upsurge in marriages and births around 1965. So by 1962, industry will be starting to tool up for new mass markets.

The important point is this: As we approach the 1960s more and more sales and investment will be in new products growing out of research. By 1960 well over 10% of manufacturing sales will be in new products not on the market in 1956.

Meanwhile — research will help stabilize capital spending by raising the level of modernization and replacement expenditures. Of course, research does not eliminate all the ups and downs in the demand for capital goods, for there remain variations in the amount spent to expand capacity. But a high level of modernization, to cut costs and improve quality, does put a floor under any drop in investment.

What To Expect

During the next few years we can expect an increasing flow of new materials, new metallic alloys, new machinery — primarily those developments coming out of long-established research programs in the chemical and electrical industries. Industry will make wider use of specialized computers and automated equipment.

But the dramatic payoff on research comes even later. In the early 1960s the consumer goods industries will begin tooling up for their really new products — things so basically new they can change the way a family lives. Such items as plastic houses, paper apparel, turbine autos are under development right now. But it will take several years to get costs down and for population and incomes to grow to the point where mass markets are created.

When we reach that point in the mid-1960s, there will begin the greatest surge of capital investment in all history. And then — around 1965 — the new processes (full automation, atomic power, continuous steel casting) which are the slowest and most expensive part of the research chain to develop, will come into play.

The combined impact of new products and new processes, to meet an expanding market, will thus be felt in the mid-1960s — eight to ten years after the recent sharp increase in research spending. The full impact is that far away because of the lags for applied research, pilot plant studies and market introduction. But to a large degree the prosperity of the 1960s has already been shaped by the research programs now underway.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

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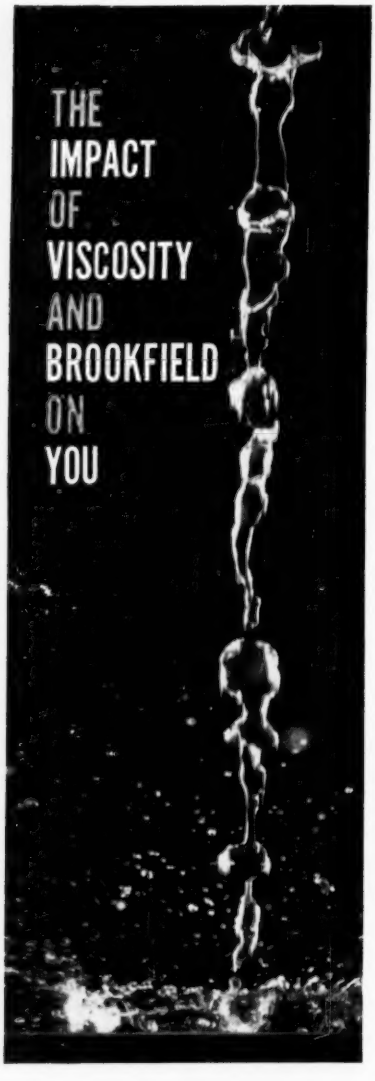

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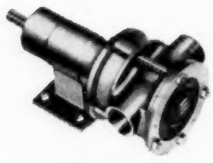

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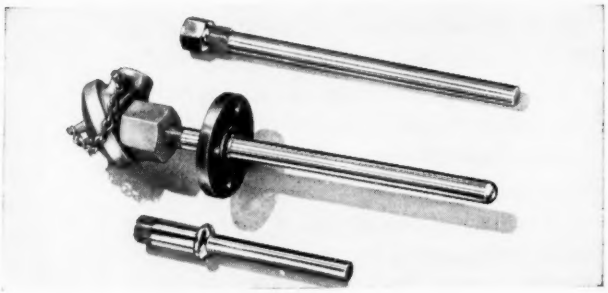

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Acid, Peracetic.....Company offers Bulletin 4, "Peracetic Acid 40%", and Bulletin 69, "Epoxidation and Hydroxylation with Becco Hydrogen Peroxide and Peracetic Acid" on this high-purity product.
61 *Becco Chemical Div.

Alcohol, Tetrahydrofurfuryl..... Quaker Oats tetrahydrofurfuryl alcohol has a new low price, many possible uses. Bulletin 206 presents its chemistry, physical properties and uses. Available on request.
10-1 *Quaker Oats Co.

Carbon Dioxide.....Liquiflow liquid carbon dioxide system assures absolute product temperature control in pulverization. Free booklet, "Applications Unlimited", describes dozens of uses.
59 *Liquid Carbonic Div.

Chemicals, Industrial.....Price schedule (effective January 15, 1958) covers tankcar, carload, less carload quantities of such materials as butanol, acetone, methanol, nitromethane, riboflavin.
241A Commercial Solvents Corp.

Clays.....Revised bulletin on Harwick clays includes typical analysis, specifications, uses, comparative data on Clay 1-P, a pulverized form of Clay 1.
Harwick Standard Chemical Co.
241B

Dimethylol Phenol Resins.....Of interest to compounders are two studies on dimethylol phenol resins as vulcanizing agents for butyl rubber. Studies are covered in Bulletins 100-4 and 100-4B.
241C Thiokol Chemical Corp.

Elastomers.....Company offers "The Du Pont Elastomers", a review of the properties of neoprene and Hypalon, and "Elastomers Notebook", with articles about the industrial use of elastomers.
217 *E. I. du Pont de Nemours.

Ethyl & Methyl Acrylate.....7 p. bulletin offers information on inhibiting polymerization of ethyl and methyl acrylate. Coverage includes tempering rate of polymerization, storage and handling.
241D Rohm & Haas Co.

Gases, Industrial....."Facts on Gases Used for Food Products" describes what a gas can do—blanketing, pressure packaging, quick freezing, mechanical processing. Gases include CO_2, N_2, H_2, argon, neon.
241E Air Reduction Co.

Lithium.....Up-to-date facts and figures on lithium and other alkali metals (cesium and rubidium) have been compiled in brochure. Covers sources, prices, principal uses and producers of lithium.
241F Montgary Explorations Ltd.

Paint Removers.....Intricacies of paint and varnish removers—what they're made of and how to test and evaluate them—are outlined in a product report. Several typical formulations are included.
241G Stauffer Chemical Co.

Phenolics.....Brochure CDC-344 describes General Electric Co.'s complete line of phenolic resins, varnishes and molding powders. Includes technical data, properties and product features.
241H General Electric Co.

Plastics, Extruded.....Included in 1958 edition of "Extruded Plastics" is information on complex shapes, rods, tubes; material property tables; applications of extruded parts in industrial products.
241I Anchor Plastics Co.

Plastics, Molded & Laminated.....12 p. booklet outlines Richardson Co. facilities for manufacturing plastics. Shows pictures and descriptions of molded and laminated applications.
241J Richardson Co.

* From advertisement, this issue

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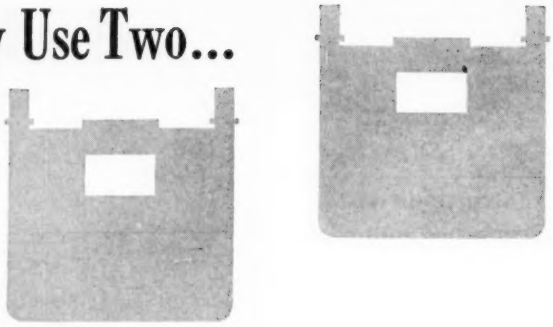

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LITERATURE . . .

Silicates.....16 p. folder, "Serving Industry," is listing of many important liquid and dry sodium and potassium silicates with their physical and chemical properties. Applications also included.
242A Philadelphia Quartz Co.

Silicones....."1958 Guide to Dow Corning Silicones" describes variety of silicones applications, e.g., adhesives, defoamers, dielectrics, heat transfer fluids, lubes, polyurethane foam additives, rubber.
242B Dow Corning Corp.

Solvents.....Booklet entitled "Shell Solvents for Low Odor and Odorless Paints" describes typical properties of Sol 71, 72, 140, 360 and mineral spirits. Available to you on request.
75 *Shell Oil Co.

Construction Materials

Alloys, Corrosion-Resistant.....Newly published 104-page booklet gives full details on physical and mechanical properties, corrosion data and fabrication information on four Hastelloy alloys.
163 *Haynes Stellite Co.

Castings.....Castings for process industries are produced in materials capable of handling liquids under pressure and heat, and are thoroughly sound. Get on mailing list for "Kutztown Review".
BL187 *Kutztown Foundry & Mach.

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205 *Atlas Mineral Prods. Co.

Fabrication.....Nooter quality and dependable schedules are your best investment when you need shop fabricated or field erected custom fabrication. "Field Erected Processing Equipment", Cat. 258.
97 *Nooter Corp.

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245 *Boardman Co.

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44 *Blaw-Knox Co.

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66 *U. S. Stoneware Co.

Steel, Rubber-Lined.....Ace rubber-lined steel has the strength and pressures of steel plus the chemical resistance of hard rubber for high pressure or big pipe lines. Bulletin CE-52.
183c *American Hard Rubber.

*From advertisement, this issue

Steels, Stainless.....You can put a curb on mounting costs by utilizing the economies of stainless steel for valves and other processing equipment. "Armco Stainless Steel Bar & Wire".
31 *Armco Steel Corp.

Titanium.....Titanium in mass production operations yields substantial savings and prevents the disruption of constant replacements. Booklet listing titanium corrosion-resistance data.
112 *Mallory-Sharon Metals Corp.

Electrical & Mechanical

Anodes.....Company offers an illustration of cell building, handsomely reproduced with no advertising text. These reproductions are now available to you upon request, free of charge.
220 *Great Lakes Carbon Corp.

Cables, Armored.....Four types of interlocked cables—600-v., 5,000-v., 15,000-v. grounded neutral, 15,000-v. ungrounded neutral—are described in 12 p. Bulletin RCP-730. Tables for each cable.
243A Rome Cable Corp.

Casters & Wheels.....Darnell casters and wheels have a wide choice of rubber treads suited to all types of floors, can be rust-proofed by zinc plating, have string guards for easy rolling. Manual.
R193 *Darnell Corp.

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B230 *Arthur Harris & Co.

Floor Boxes.....24 p. bulletin contains pictures and cross-sections of all types of R & S floor boxes. Includes descriptions of adjustable rectangular and round types, elbows, floor extension sets.
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190a *U. S. Gasket Co.

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108 *Louis Allis Co.

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12-3 *Elliott Co.

Packings, Teflon.....Chempro Teflon packings last for many months under corrosive conditions that destroy conventional packings in days or hours. They give a truly tight seal. Bulletin CP 552.
R187 *Chem. & Power Products.

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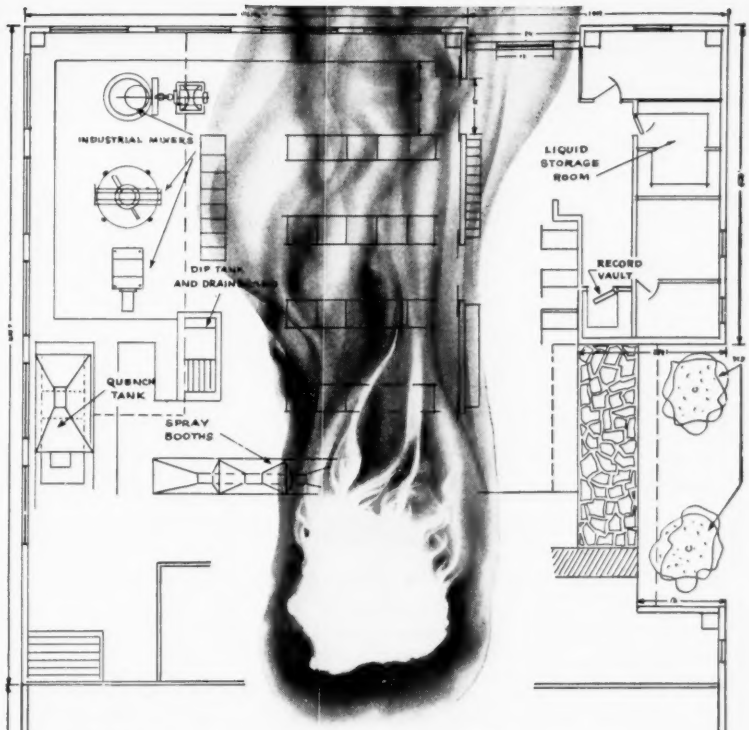

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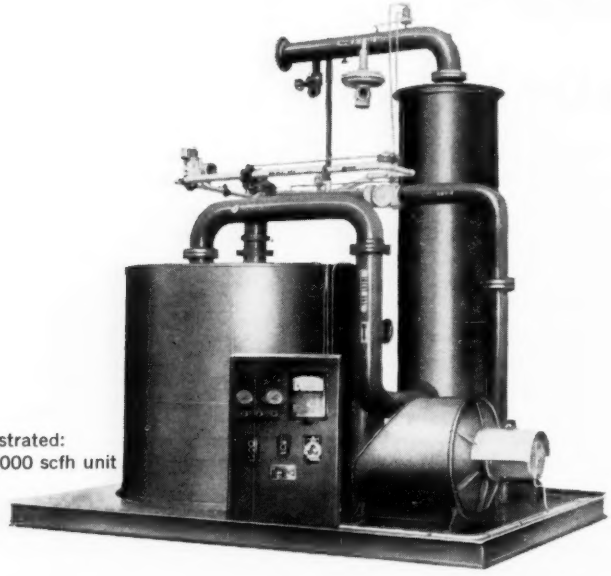

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LITERATURE . . .

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43 *Square D Co.

Rectifiers.....Company specializes in semiconductor power conversion equipment and systems and promises the flexibility of modifying designs to meet exacting requirements. Request "Guide".
TL251 *Sel-Rex Corp.

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199 *Crane Packing Co.

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176-7 *Dodge Mfg. Corp.

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221 *Terry Steam Turbine Co.

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235 *Clayton Mark & Co.

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237 *Cambridge Wire Cloth Co.

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56 *Dracco Div.

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2 *Girdler Co.

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B246 R. D. Cole Mfg. Co.

Tanks, Storage.....12-page booklet gives specifications and money-saving facts about sanitary, weatherproof bulk storage tanks which may be pneumatically or mechanically filled. Bul. 574.
206 *Day Co.

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Waste Disposal.....The one-man, one-truck Dempster-Dumpster can service over a hundred accumulation points, picking up, hauling and emptying the containers. "How to Reduce Waste Disposal Costs."
213 *Dempster Brothers.

Heating & Cooling

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155 *Henry Vogt Machine Co.

Burners.....Company's burners have automatic proportioning so that the precise amount of air needed for complete combustion is constantly mixed with the gas. Send for your Bulletin SC-156.
R251 *Surface Combustion Corp.

Coolers.....New booklet on flash coolers discusses various construction materials, flash nozzles and other adaptations. Sections on single stage vs. multiple stage cooling. Bul. SW-204.
85 *Swenson Evaporator Co.

Evaporators, Vapor Compression..... Low-cost, economical vapor compression evaporators produce distilled water for energy-cost as low as 51 cents per thousand gallons. Vapor Compression Cat.
40 *Cleaver-Brooks Co.

Heat Transfer Equipment.....“Aero” evaporative heat exchangers, after coolers and condensers have high operational efficiency and real economy in upkeep. Bulletins 129, 130, 132, 136R.
247 *Niagara Blower Co.

Heaters.....Prefabricated Gradiation heaters are complete when they are shipped out and can be erected on job-site foundations in less than eight hours. Request a copy of helpful Bulletin 143.
222 *Selas Corp. of America.

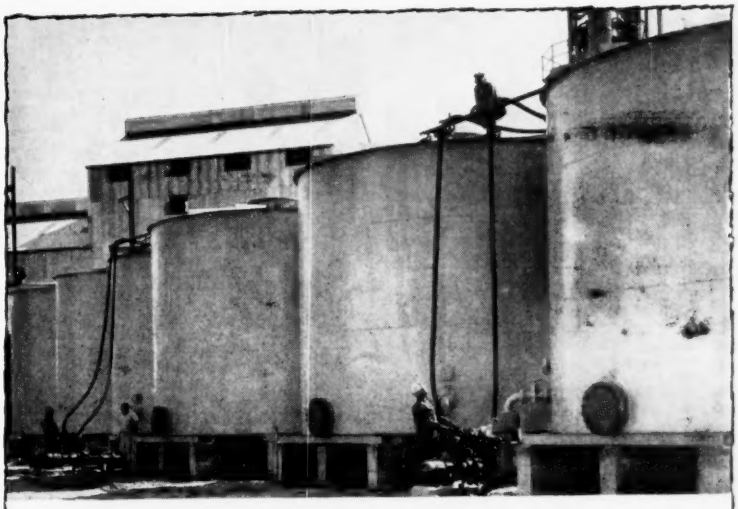
Heaters-Coolers.....68 p. catalog describes technical and theoretical aspects of drying: construction details, sizes, equipment layouts. Covers dryers, coolers, calciners, kilns. Bulletin 118.
245A C. O. Bartlett & Snow Co.

Kilns.....Traylor kilns have easy aligning, single roller supports and “full-floating” tires which float free of the shell as it contracts and expands. Request Bulletin #1115 for data.
32 *Traylor Eng. & Mfg. Co.

Thermocouple Assemblies.....Thermocouple Catalog Section E-E discusses thermocouples, connection heads and thermowells. Extremely wide variety, pre-tested quality, simple ordering.
BR240 *Thermo Electric Co.

Thermo-Panels.....Bulletin 355 has 52 pages of technical data on thermo-panel coils; Bulletin 258 gives prices and design data enabling you to do your own estimating and designing.
T230 *Dean Products Co.

*From advertisement, this issue



From Engineering to Erection . . .

BOARDMAN produced these acid tanks for CHEMICALS OZARK MAHONING MINERAL PRODUCTS

Here was a typical metalcrafting job which made use of BOARDMAN's 46 years' experience all the way from the drawing board to in-place completion. Ozark-Mahoning's Tulsa, Oklahoma chemical fertilizer plant needed phosphoric acid storage tanks. Starting with the customer's specifications, BOARDMAN contributed suggestions for improved design . . . engineered the tanks . . . fabricated them of carbon steel, with special welding to permit rubber lining . . . and then erected the units. Other dependable BOARDMAN metal products on this job include a 100-foot steel stack and a connecting fume disposal incinerator.

No matter what your metalcrafting requirements may be, it will pay you to investigate BOARDMAN's outstanding facilities and know-how. At your request, a BOARDMAN sales-engineer will fly to your office for direct consultation.

Working with metal is a specialty at . . .

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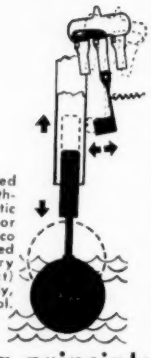
THE BOARDMAN CO.
OKLAHOMA CITY, OKLAHOMA

Write for the brochure "Working with Metal . . . at Boardman."

permanent magnetic force...



A sleeve, raised and lowered within a nonmagnetic tube, attracts or releases an Alnico magnet attached to the mercury (or dry contact) switch. Basically, this is Magnetrol.

The operating principle behind MAGNETROL LIQUID LEVEL CONTROL

Because its operating principle, based on the proper use of a permanent magnet, guarantees a perpetual guardianship over your critical liquid levels, the Magnetrol liquid level control unobtrusively takes the most important place in any system or process where it is necessary to keep a liquid at a constant level. Principle and action are so simple that failure is virtually impossible. Magnetrol is versatile, too—will handle almost ANY liquid, at ANY temperature, at ANY pressure, with the same precision and dependability. No mechanical or electrical linkages to stick, bind, ride out of line or wear out. Available for controlling level changes from ⅛" to 150 ft. Multi-stage switching when desired. Write to

MAGNETROL, Inc., 2124 S. Marshall Blvd., Chicago 23, Illinois

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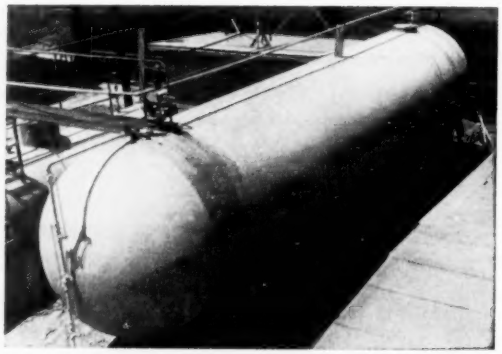
Backed by 103 Years of Fabrication Experience



• We have been supplying the chemical processing industry with tanks and vessels for chemical storage for three generations. In addition to carbon and stainless steel, we also fabricate and erect tanks, pressure vessels and processing equipment of aluminum and special alloys. . . . Investigate our facilities and take advantage of our 103 years of specialized knowledge and experience. . . . Write for *Tank Talks.*

R. D. COLE MANUFACTURING CO. COLE NEWNAN, GEORGIA

Elevated Tanks, Pressure Vessels, Chemical and Processing Equipment from Aluminum, Stainless and Carbon Steel, Monel and Other Alloys.

Established 1854

R. D. COLE MANUFACTURING CO.
NEWNAN, GEORGIA

LITERATURE . . .

Towers, Cooling.....Company offers "Answers to the 15 Questions About Pritchard Induced Draft Cooling Towers" with a wealth of information. New drift eliminators and distribution system.
214 *J. F. Pritchard & Co.

Traps, Steam.....Thermostatic steam traps have same head and seat for all pressures to 300 psi, are compact, light and freeze-proof and have only one working part. Full details in Bulletin 250.
216 *Sarco Co.

Instruments & Controls

Comparators.....Lightweight, portable comparators make accurate colorimetric tests for pH, chlorine, phosphates, nitrates, etc. Free handbook, "Modern pH and Chlorine Control" is offered.
L249 *W. A. Taylor & Co.

Controllers, Pressure.....For optimum pressure control, specify company's pressure controllers and transmitters. Features of vibration proof power unit include push button cleanout. Bul. 72-14.
55 *Black, Sivall & Bryson Inc.

Instruments.....Technical Publication ND46, entitled "New Horizons", gives data on circuitry and performance characteristics of Speedomax instruments, such as the Army missile program uses.
50 *Leeds & Northrup Co.

Meters.....The Print-O-Meter gives printed proof of delivery and automatic control of liquids going the batch, prints exact quantities with serial numbers and code letters. Bulletin 567-H.
250 *Neptune Meter Co.

Meters, Gas.....Company's gas meters assure unalterable accuracy with far less maintenance than other types require. No valves, valve gear or other small parts to wear out. Bulletin M-152.
242 *Roots-Connersville Blower.

Meters, Viscosity.....Accurate viscosity measurement, evaluation and control can turn chance to science, waste to wealth. Company offers a brochure on viscometers and allied equipment.
L240 *Brookfield Eng. Labs.

Recorders.....American-Microsen Series 130 recorder has simple design, precision components and rugged construction for sustained accuracy and freedom from maintenance. Request Bulletin MG10.
122 *Manning, Maxwell & Moore.

Regulators, Flow Rate.....Kates flow rate regulators can control liquid rate of flow at any pressure, constant or varying, and can blend two or more fluids efficiently. Bulletin 561.
178 *W. A. Kates Co.

Thermometers, Industrial.....Catalog 125A, on industrial thermometers, contains all pertinent engineering data about units plus complete set of standard temperature ranges and scale divisions.
246A Weksler Thermometer Corp.

* From advertisement, this issue

Pipe, Fittings, Valves

Fittings & Flanges.....Insert flanges provide leakproof joints without welding and maintain high quality control standards. "Speedline Catalog" describes line of corrosion resistant fittings.
101 *Horace T. Potts Co.

Flanges, Forged Steel.....Phoenix forged-steel flanges are used on popular Yarway Gun-Pakt expansion joints for steam distribution lines. Phoenix offers a free, 36-page pocket reference manual.
36 *Phoenix Mfg. Co.

Hose, Flexible Metal.....Flexible stainless steel hose has leakproof qualities, durability, strength and lightness. Stands up to high temperature and pressure corrosive materials. Bul. 21-A.
39 *Atlantic Metal Hose Co.

Hose, Industrial.....32 p. catalog of industrial hose couplings, stems, swivels and accessories includes sections on hose types; application, selection, mounting of hose; how to apply hose clamps.
247A J. N. Fauver Co.

Joints, Expansion.....Chemiseal expansion joints and flexible couplings, made of Teflon, protect piping against shock, vibration, thermal expansion and contraction. Request free Catalog AD-137.
190b U. S. Gasket Co.

Nozzles, Spray.....Two types of spray nozzles available—Involute for fine hollow cone spray and Fan-Spray for flat, fan-shaped spray with time-saving slicing action for cleaning. Bulletin N-618.
L204 *Yarnall-Waring Co.

Pipe.....Company offers you a handsome, illustrated brochure which shows Flori-Houston's complete facilities, fabrication processes and outstanding examples of pipe fabrication jobs.
117 *Flori Pipe Co.

Pipe, Glass.....New Pyrex pipe bulletin tells you something of the long history of this pipe in chemical processing, examines its many advantages over conventional piping and lists sizes.
14-5 *Corning Glass Works.

Pipe, Rubber.....Tempron heat-resistant nitrile hard rubber pipe handles inorganics at 250-275 deg. F. and resists a wide range of organic chemicals at room temperature. Bulletin 96-A.
182a *Amer. Hard Rubber Co.

Pipe, Rubber-Plastic.....General-purpose moderately priced rubber-plastic pipe handles most common chemicals to 170 deg. F; it is tough, rigid, odorless and tasteless. Bulletin 80 is offered.
182d *American Hard Rubber.

Pipe & Sheet, PVC.....Company offers booklets on rigid Koroseal polyvinyl chloride pipe and sheet. Also available in rods and valves. Strong, chemically resistant, low in cost. Send for your copy.
266 *B. F. Goodrich Ind. Prods.

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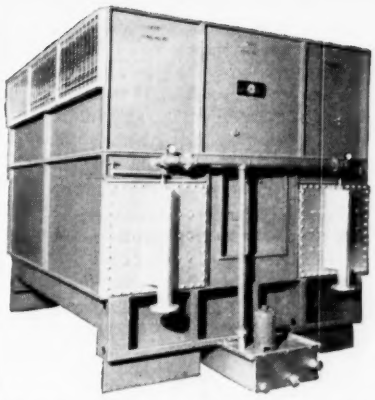

Is your plant CRITICALLY SHORT of WATER?

● You will make major water savings, reduce your costs, solve your problems of water supply or disposal and get HIGH OPERATIONAL EFFICIENCY with Niagara "Areo" Evaporative Heat Exchangers, After Coolers or Condensers for these important plant services or processes:

- **AFTER COOLING and air drying for large air and gas compressors and AIR LIQUEFACTION**
- **COOLING ENGINES, COMPRESSORS, HYDRAULIC PRESSES**
- **COOLING QUENCH BATHS, FURNACES, INERT ATMOSPHERES**
- **COOLING ROLLS, WELDERS, DRAWING OR EXTRUSION DIES**
- **PRODUCT AND PROCESS COOLING CHEMICALS OR INTERMEDIATES**
- **COOLING LIQUIDS OR GASES IN CLOSED SYSTEMS**
- **VAPOR CONDENSING UNDER VACUUM**
- **ELECTRONIC PROCESS COOLING**

High operational efficiency means: precise temperature for improved product and process quality control, heat removal at rate of input, simple operating conditions, real economy in upkeep, sustained full capacity.

Also it means cooling in a closed system with your product kept free from contamination or, when condensing, getting a pure condensate holding high quality in your product or material.

Niagara machines do the work of a cooling tower plus shell-and-tube coolers with a single machine that saves piping, water handling disposal and treatment expense and 95% of water consumed by contact cooling methods.

Write for Bulletin 129, 130, 132, 136R.

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Over 35 years of Service in Industrial Air Engineering

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District Engineers in Principal Cities of U. S. and Canada

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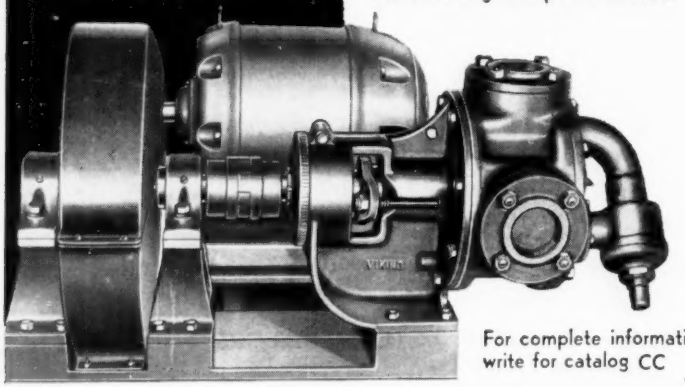
Specify **VIKING** Heavy Duty **PUMPS**

When jobs require rugged pumping, you can depend upon Viking Pumps. All are fast self-priming and positive in action. Models are built to handle liquids ranging from LP-Gas up to those of a viscosity of 2,500,000 SSU.

Choose yours in sizes of 10, 20, 35, 50, 90, 150, 200, 300, 450, 750 and 1050 G.P.M. Suitable for pressures to 200 psi on lubricating liquids, or 100 psi on non-lubricating liquids. Built of many types of metals and combinations of metals. Available in any type of mounting and power desired.



For complete information, write for catalog CC

VIKING PUMP COMPANY

Cedar Falls, Iowa, U.S.A. In Canada, it's "***ROTO-KING***" pumps

See Our Unit in Chemical Engineering Catalog

(Two of a series)

IS YOUR *WATER* AS GOOD AS YOUR *ION EXCHANGER* IS CAPABLE OF PRODUCING?

HMM Ion Exchangers utilize a fixed *underdrain** that functions without moving parts or a retaining bed. Higher water quality and operating economies are immediately apparent:

- √ Protect treated water quality
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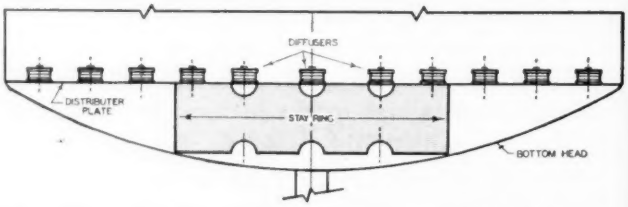
*THE HMM UNDERDRAIN FEATURE IS PATENT PENDING



FIELD tested and proved in hundreds of installations, they are suitable for use on any type Ion Exchanger, as well as standard equipment on all HMM Deionizers, Cation Exchangers, Anion Exchangers and Softeners.

FREE: Write for our Water Treatment "Fact-File-Folder"

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3338 GORHAM AVENUE, MINNEAPOLIS 26, MINNESOTA ***Phone: WEst 9-6774***

"Natural water is a *raw* material; it should be *refined* before use."

LITERATURE . . .

Tubing, Flexible.....Company's flexible, corrugated or interlocked tubing is available in bronze, galvanized or stainless steel in sizes from ⅛" to 24" I.D. Send for "Flexineering" guide.
194 *Pa. Flex. Metallic Tubing.

Tubing, Stainless Steel.....Welded stainless steel tubing resists corrosion because it is fully annealed and precision made. It provides ease of fabrication and close tolerances. Bul. TB-415.
128 *Babcock & Wilcox Co.

Valves.....The design and precision manufacture of non-lubricated steel plug valves assure quick, easy, dependable operation and absolute shut-off at high and low temperatures. Catalog.
107 *Wedgeplug Valve Co.

Valves.....Jenkins Practical Piping Layouts, Volume 3, is a 36-page collection of 25 basic piping diagrams with recommendations for valve selection and location in the lines. Free on request.
168 *Jenkins Bros.

Valves.....For complete information about Crane alloy valves for the processing industries—application recommendations, materials, sizes, ends available, companion fittings—get Circular 2080.
129 *Crane Co.

Valves.....56 p. catalog incorporates detailed cross-section illustrations and data to aid in the selection and applications of valves featuring Shear-Seal leakproof principle. Catalog 58-59.
248A Barksdale Valves.

Valves, Check.....By taking a Basic-Check Unit and combining it with any standard pipe fitting, you get a complete check valve for practically any service. Operate in any position. Bul. CE-38.
184 *Durabla Mfg. Co.

Valves, Corrosion-Resistant.....There is an Ace hard rubber, rubber-lined or plastic-lined valve for every corrosion application. Sizes from 2" to 24". Diaphragm, gate, check types. Bul. CE-52.
183B *American Hard Rubber Co.

Valves, Stainless Steel.....Valves have bowed yoke, extra deep stuffing box, extra large handwheel, replaceable yoke nut and swinging eyebolts. "Design Factors in Stainless Steel Valves."
114 *Cooper Alloy Corp.

Valves, Swing Check.....Swing check valve lined with hard rubber for best corrosion resistance. Large, straight-through flow areas; sensitive to slight pressure differential. Bul. CE-52.
182C *American Hard Rubber.

Process Equipment

Blenders.....“Twin-Shell” blenders provide fast, uniform blends, dust-free, moisture-proof operation and quick, easy discharging. Bulletin 15a-1 on lab models, Bul. 15 on production types.
68 *Patterson-Kelley Co.

*From advertisement, this issue

valuable time-savers!

TAYLOR COMPARATORS

let you make ACCURATE pH, CHLORINE TESTS in MINUTES!

Here's a really fast—and easy—way to make accurate colorimetric tests for pH, chlorine, phosphates, nitrates, etc. Lightweight, portable Taylor Comparators give you dependable, on-the-spot operational data in minutes . . . not hours! Help you control crystallization, bleaching, precipitation, extraction or waste treatment faster. Tests are made simply by placing the treated sample in the middle tube and moving the color standard slide across until the sample matches one of the standards. Values are then read directly from the slide.

Many Taylor Comparators serve for several determinations with only a change of color standard slides.

COLOR STANDARDS GUARANTEED

All Taylor liquid color standards carry an *unlimited guarantee against fading*. Be sure to use only Taylor reagents and accessories with Taylor Comparators to assure accurate results.

SEE YOUR DEALER for Taylor sets or immediate replacement of supplies. Write direct for FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Illustrates and describes complete Taylor line.

W. A. TAYLOR AND CO.
414 STEVENSON LANE • BALTIMORE 4, MD

LITERATURE . . .

Centrifugals.....Company's machines are used for separation, extraction, dehydration, clarification, coating, filtration, draining, thickening, sedimentation, etc. "Centrifugal Force" booklet.
223 *Amer. Tool & Machine.

Dryers.....Compact, highly effective Roto-Louvre dryers introduce dry, heated air through ever-changing channels, the entire surface of every particle to uniform treatment. Request Book 2511.
175 *Link-Belt Co.

Dust Collectors.....Jet-action Mikro-Pulsaire units provide around-the-clock dust collection and full-time automatic cleaning. Extra-long filter media life is assured. Bulletin 52A.
109 *Metals Disintegrating Co.

Dust Collectors.....Dry-type dust collectors provide the continuous operation needed to capture nuisance dusts and recover usable product without down-time for sludge clearance. Bul. DC-49.
201 *Ducon Co.

Exhausters.....Industrial exhausters are available in a variety of models, capacities and arrangements to handle your air or material handling jobs efficiently. Request Bulletin 3576-B.
58a *Buffalo Forge Co.

Filter Cloth, Metallic.....For the most uniform, most accurate metallic filter cloth, specify Newark. Company manufactures all weaves, all metals for all types of services. Catalog E.
198 *Newark Wire Cloth Co.

Filter Presses.....Filter presses can be custom-engineered to meet your requirements for flow rate, cake build-up, washing, extraction and thickening. Fully illustrated reference manual available.
203 *D. R. Sperry & Co.

Filters.....Cyclamatic type 117 continuous pressure filter is a series of vertical tubes in a circular pattern fitting into a common manifold. Multiple layers of filter media. Bul. 117.
170 *Industrial Filter & Pump.

Filters, Vacuum.....Single cell rotary vacuum filters offer the highest capacity per foot of filter area, effective discharge of very thin cakes, multi-stage, counter-current washing. Bulletin.
4 *Bird Machine Co.

Generators, Inert Gas.....New Sub-X inert gas generators provide a source of inert or purge gases that is compact in size, highly efficient and extremely economical to operate. Bulletin 114.
244 *Thermal Research & Eng.

Milling, Chemical.....Up-to-date discussion on chemical milling covers, with illustrations, such topics as chemical milling, its advantages, application check list, design factors and recommendations.
249A U. S. Chemical Milling Corp.

Mills.....Imp mill with flash drying accessories removes moisture from material while it grinds. Clean, dust-free, automatic system for producing the softer non-metallic substances. Catalog 77.
130 *Combustion Engineering.

*From advertisement, this issue

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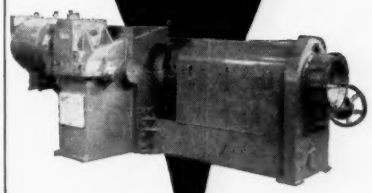

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DEWATERING Applications

Dryers

Solvent extraction equipment

Solvent recovery systems

The French Oil Mill Machinery Co. has specialized in extraction machinery for the oil milling industry for over 50 years with an outstanding record of achievement.

This experience in the profitable handling of extraction problems is now available to the chemical industry. Write today for suggestions on the most profitable method of handling extraction or de-watering.

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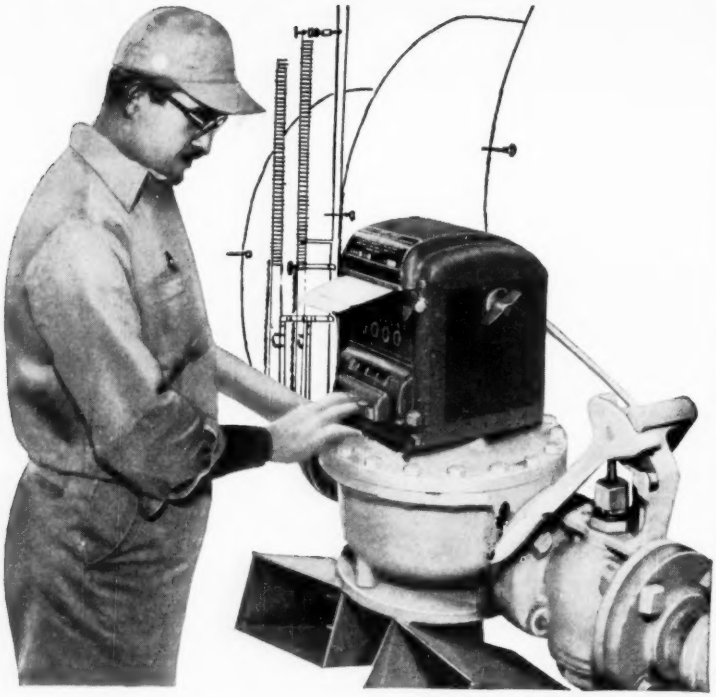

New quality control-
Meter-Printed Batch Tickets with
NEPTUNE *liquid* METERS

Get printed proof of delivery and automatic control of liquids going into the batch . . . with the Neptune Print-O-Meter. Prints exact quantities, with serial numbers and code letters to identify the batch and/or station. Foolproof operation . . . ticket is inserted and locked in place in meter before delivery. Ticket cannot be removed before being printed out.

You get quality control and dispute-free printed records of delivery if you handle any of these liquids (and others too!). Print-O-Meter sizes: 1 to 4 in., capacities 5 to 500 gpm. Other meters 2 to 1000 gpm.

Send for free Technical Metering Bulletin 567-H.

How many of these liquids can you handle better with Neptune?

Acetates	Lime Water
Acetone	Linseed Oil
Alcohol	Liquid Soap
Ammonium Nitrate	Liquid Sugar
Ammonium Sulfate	Lubricating Oil
Banana Oil	Methylated Spirits
Barium Chloride	Methyl Bromide
Benzol	Methyl Formate
Borax Solution	Methyline Chloride
Brine	Mineral Spirits
Bunker "C"	Molasses
Butanol	Naphtha
Calcium Chloride	Oleic Acid
Carbon Bisulphide	Oleum Spirits
Carbon Tetrachloride	Paint
Castor Oil	Paraffin Oil
Cellulose Solvent	Paste
China Wood Oil	Perfume
Chloropicrin	Pine Oil
Chocolate	Plasticizer
Cocoa Butter	Polymer, Molten
Coconut Oil	Propylene Glycol
Coffee	Pyrethrum Mixtures
Condensate	Rum
Corn Syrup	Shellac (Alcohol)
Cotton Seed Oil	Silicone Oil
DDT	Soap Solution
Dextrine Solution	Sodium Benzoate
Diacetone	Sodium Carbonate
Dibutyl Phthalate	Sodium Chloride
Diethyl Carbitol	Sodium Silicate
Diethylene Glycol	Soy Bean Oil
Dimethyl Phthalate	Starch Solution
Ethyl Cellosolve	Stearic Acid
Ethylene Glycol	Styrene Monomer
Fish Oil	Sugar Syrups
Formaldehyde	Tallow
Freon	Tannic Acid
Fuel Oil, Hot	Trichlorethylene
Glucose	Tungwood Oil
Glue, Water Sol.	Turpentine
Glycerine	Varnish
Grease	Vinyl Lacquer
Ink	Water
Isobutylene	Wax Emulsions
Isopropanol	Whiskey
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LITERATURE . . .

Mills, Pebble & Ball.....For quality-controlled, low cost dry or wet grinding, mixing or blending, Abbe pebble and ball mills are unequalled in production speed and service life. Catalog 77.
R253 *Abbe Engineering Co.

Presses, Dewatering.....New continuous dewatering press was built to withstand the extremely heavy service required in the pulp and paper field. Catalog A.
BR236 *Davenport Mach. & Foundry

Processing Equipment.....24 p. bulletin (No. 380) gives mechanical descriptions and specifications of equipment such as evaporators; pan, drum, rotary, vacuum dryers; auto-claves; kettles; mixers.
250A Buflovak Equipment Div.

Processors.....Holo-flite processors handle processes where slurries, granular solids, pulps or pastes are cooled, heated or dried in continuous flow. Many possible heat transfer agents. Bul.
46 *Western Precipitation Corp.

Pulverizer-Classifiers.....The Pulvocron is an air attrition impact pulverizer and classifier with controlled radial inward air classification, plus an automatic feeder. Bulletin.
99 *Strong-Scott Mfg. Co.

Reactors, Glassed Steel.....Side to side piping is possible with new "R" Series glassed steel reactors. Drive mount adds space and flexibility; stuffing box or seal can be changed quickly. Bul. 960.
268 *Pfaudler Co.

Scrubbers, Fume.....Bulletin B-71 offers detailed descriptions of scrubbers used in chemical plants, metal treatment, refining, anodizing, etc. Cases show use of wet cyclone and packed tower types.
250B Heil Process Equipment Corp.

Strainers, Pipeline.....Yarway pipeline strainers have Monel wire filter cloth for maximum straining service and minimum flow restriction. Wide range of sizes and pressures. Bulletin S-205.
47 *Yarnall-Waring Co.

Water Treatment.....HMM ion exchangers protect treated water quality, simplify operation, decrease rinse water consumption, decrease regeneration time and eliminate underbed distortion. Folder.
B248 *H. M. Mueller Corp.

Water Treatment Equipment.....Company recommends reprints of a series of advertisements, "How to Select Water-Conditioning Equipment", as a handy "short course" for students and engineers. Free.
24 *Permutit Co.

Pumps, Blowers, Compressors

Compressors.....If you need oil-free air, take advantage of Joy's more than twenty-five years of experience with non-lubricated compressors and send for a copy of free Bulletin No. 130-11.
7 *Joy Mfg. Co.

*From advertisement, this issue

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We don't make pop-up toasters or television sets—our business is Semiconductor Power Conversion Equipment and Systems. This intense specialization assures you of the best rectifier equipment it is possible to build—plus the flexibility of modifying designs to meet specific, exacting requirements. Such valuable EXTRAS are evident in every Sel-Rex Rectifier installation. Send for FREE "GUIDE" to Industrial Rectifier Equipment.

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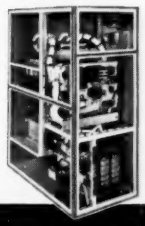

Rectifier Division

SEL-REX CORPORATION

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Representatives in Principal Cities

"Complete Semiconductor Power Conversion Systems for any AC to DC application."

Men on the Move

Now available
in a *new edition* . . .
with *new figures.*

This popular booklet points up the important sales problem of personnel turnover in industry. Out of every 1,000 key men (over a 12-month period) 343 new faces appear . . . 65 change titles . . . 157 shift . . . and 435 stay put. These figures are based on average mailing address changes on a list of over a million paid subscribers to McGraw-Hill magazines.

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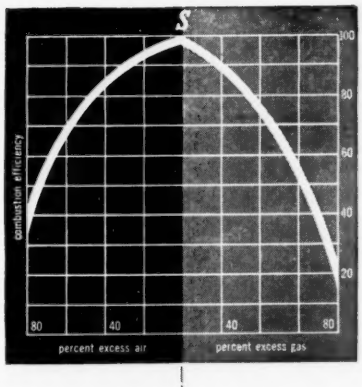

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Compressors.....“Air for Industry” covers M-Line compressors, 200 to 10,000 hp, and tells about the new things being done by one of America’s oldest compressor companies. Bul. M-81.
229 *Cooper-Bessemer Co.

Compressors, Rotary.....Rotary compressors eliminate shake, shimmy and shock, need no heavy foundations. Bulletin 16B8244 on two-stage types, Bulletin 16B8126 on single-stage types.
123 *Allis-Chalmers Mfg. Co.

Fans.....Belted vent sets are especially adaptable to smaller ventilation system needs, or for use where central system ventilation requires augmentation. Quiet, stable performance. Bul. 3720-A.
58b *Buffalo Forge Co.

Pumps.....Moyno pumps successfully handle hundreds of formerly unpumpable materials, including highly abrasive or corrosive materials, from thin slurries to very viscous material. Bul. 30-CE.
37 *Robbins & Myers Inc.

Pumps.....Before deciding on the type of pumps you need, read these Taber bulletins. Bulletin V-837 discusses vertical pumps for handling chemicals; Bulletin C-355 discusses horizontal pumps.
179 *Taber Pump Co.

Pumps.....New applications for Apco Z4 pumps include the handling of liquefied petroleum gases, refrigerants and other non-viscous liquids. Obtainable in any machineable alloy. Bul. 111-ZA.
TR204 *Aurora Pump Div.

Pumps.....Heavy duty pumps are fast self-priming and positive in action. Models are built to handle liquids ranging from LP-Gas up to those with a viscosity of 2,500,000 SSU. Cat. CC.
T248 *Viking Pump Co.

Pumps, Acid.....Jabsco neoprene-impeller pump made of hard rubber outlasts and out-pumps anything in its pressure, size and price class. Bulletin 97-A is available to you upon request.
182b *American Hard Rubber.

Pumps, Chemical.....Ingersoll-Rand chemical pumps are available in sizes to handle up to 4,000 gpm at temperatures to 800F. They give you extra protection against corrosion. Bulletin 7095-A.
105 *Ingersoll-Rand.

Pumps, Controlled-Volume.....Bulletin 440 contains typical applications, flow charts, description and specifications of manually controlled and Auto-Pneumatic models of Pulsafeeder pumps. Free.
57 *Lapp Insulator Co.

Pumps, Fire.....Fire Pump Bulletin 5814F describes horizontal pumps, while Bulletin 6920F describes vertical pumps. Company will provide the exact type and size you need for dependability.
64 *Fairbanks, Morse & Co.

Pumps, Glassed.....New glassed pump offers excellent corrosion resistance, elimination of stuffing box problems, freedom from contamination, mechanical strength and economy. Bulletin 725.2.
18-9 *Goulds Pumps Inc.

* From advertisement, this issue

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LITERATURE . . .

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191 *Lawrence Pumps Inc.

Pumps, Metering.....New Chemical Feeder Catalog is the most complete, most useful catalog on metering pumps ever published. It gives detailed engineering data in thirty-six pages. Free.
202 *Manzel Div.

Pumps, Vacuum.....Combination two-stage vacuum pump gives top service at the low micron range, with faster pump-down, faster recovery and lower blank-off pressure. Request new Bulletin 95.
L236 *Beach-Russ Co.

Ventilators, Roof.....Selection guide to Ilg low-silhouette line of power roof ventilators describes series for exhaust and supply. Includes dimensions, capacity tables and details on accessories.
254A Ilg Electric Ventilating Co.

Services, Processes, Misc.

Crushing, Laboratory.....Laboratory crushing and grinding machines include crushing rolls, jaw crushers, swing-sledge mills and sample grinders. Rugged, accurate, dependable. Bul. 067.
48 *Sturtevant Mill Co.

Fair.....1958 German Industries Fair at Hanover will show exhibits of more than 4,000 European and overseas manufacturers of machinery, precision equipment and consumer goods. Leaflet.
BL251 *German-American Trade Office.

Fire Extinguishing Systems.....Booklet describes pressure operated carbon dioxide fire extinguishing systems which snuff fires out in seconds without harming machinery or leaving a mess.
243 *Walter Kidde & Co.

Hydraulic Tables.....Bulletin No. 3300 furnishes conversion tables, decimal equivalents, hydraulic ram capacities, wire and sheet metal gages, steel pipe tables, strength of materials, bolt tables.
254B Hamilton Div.

Laboratory Equipment.....180-page catalog describes line of laboratory equipment and furniture which will give you the maximum working and storage area in a minimum of space. Free.
TR236 *Metalab Equipment Co.

Processing Laboratory.....Research and testing laboratory for solving problems in drying, evaporation, extraction, mixing, crystallization and other processes is described in Bulletin 381.
254C Buflovak Equipment Div.

Ovens, Laboratory.....Laboratory oven can dehydrate chemicals desert dry, reducing moisture content from 15% to 3-4% in less than two hours. Superior airflow characteristics. Bul. 100.
BR204 *Despatch Oven Co.

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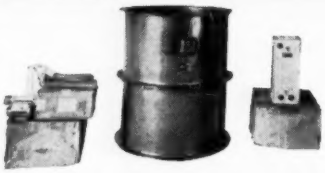

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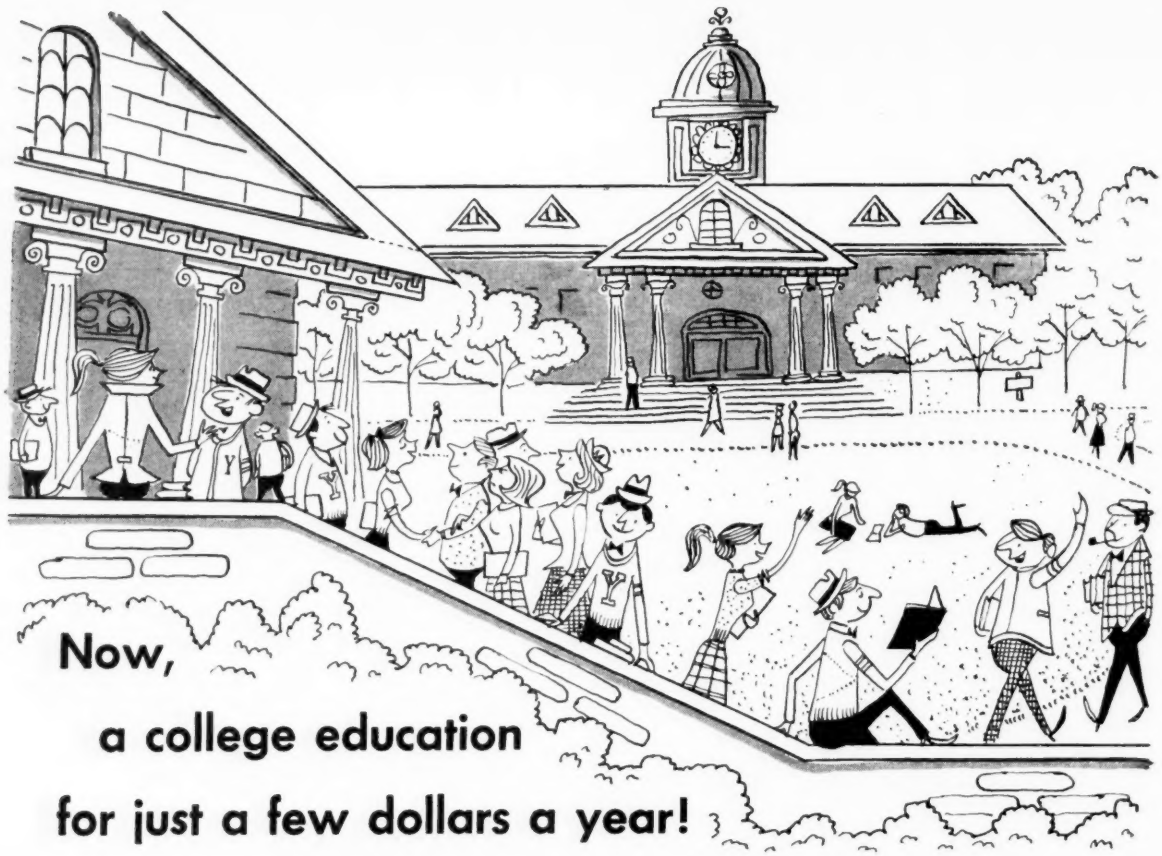

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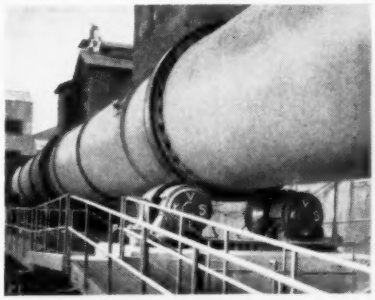

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- Self-aligning bearing pedestals.
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- Truly effective air seals.
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- Built in any length or diameter.
- Designed to give economical, efficient operation over long periods.

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How to keep informed on the "with what" part of your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information – advertising. You might call it the "with what" type – which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking *his* most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

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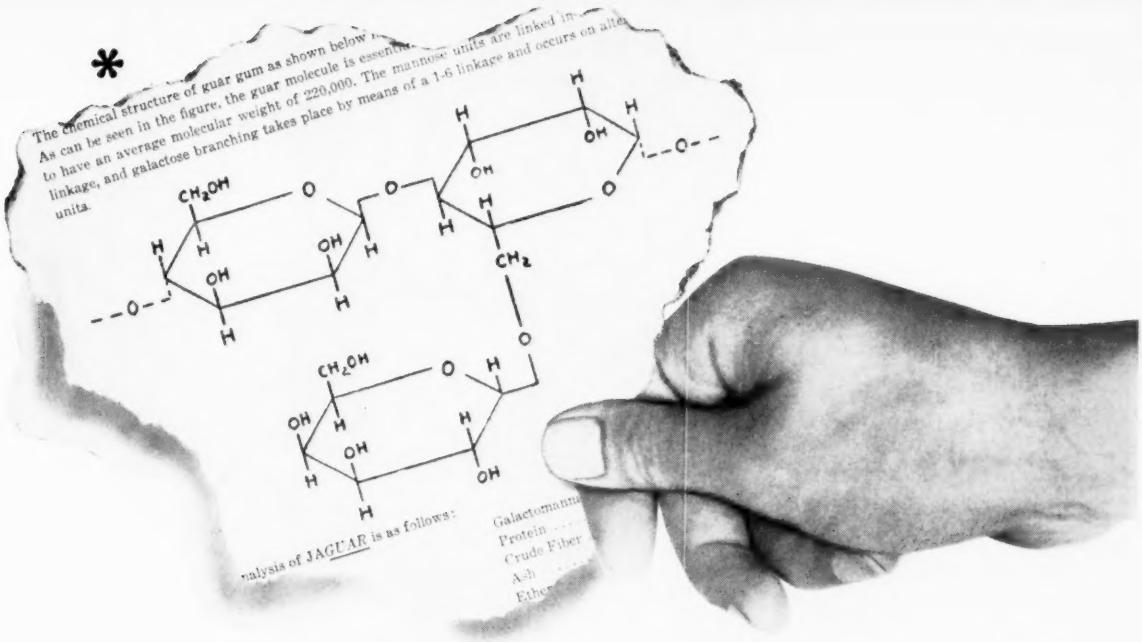
*
The chemical structure of guar gum as shown below
As can be seen in the figure, the guar molecule is essenti
to have an average molecular weight of 220,000. The mannose units are linked in
linkage, and galactose branching takes place by means of a 1-6 linkage and occurs on alte
units.
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OH
CH2
Galactomanna
Protein
Crude Fiber
Ash
Ether
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- **JAGUAR** is a cold water swelling, non-ionic type of polysaccharide
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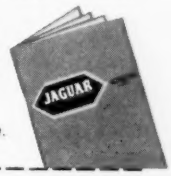
- **JAGUAR** has excellent thickening, film forming and stabilizing properties
- **JAGUAR** in trace quantities has excellent flocculating and filter-aid properties
- **JAGUAR** is a natural vegetable pure food colloid
- **JAGUAR** is available in 28 standard types and can be tailor-made to meet specific end use requirements
- **JAGUAR** is *exclusive with Stein-Hall* and is produced domestically in Stein-Hall plants
- **JAGUAR** is economical to use
- **JAGUAR** is freely available in large tonnage quantities

We invite your inquiry regarding this amazing new product, developed and produced by Stein-Hall. For technical data, send for FREE 16-page, detailed JAGUAR booklet and free sample. Write on your company letterhead — or fill in this coupon.



*Molecular structure from page 6 of this booklet.

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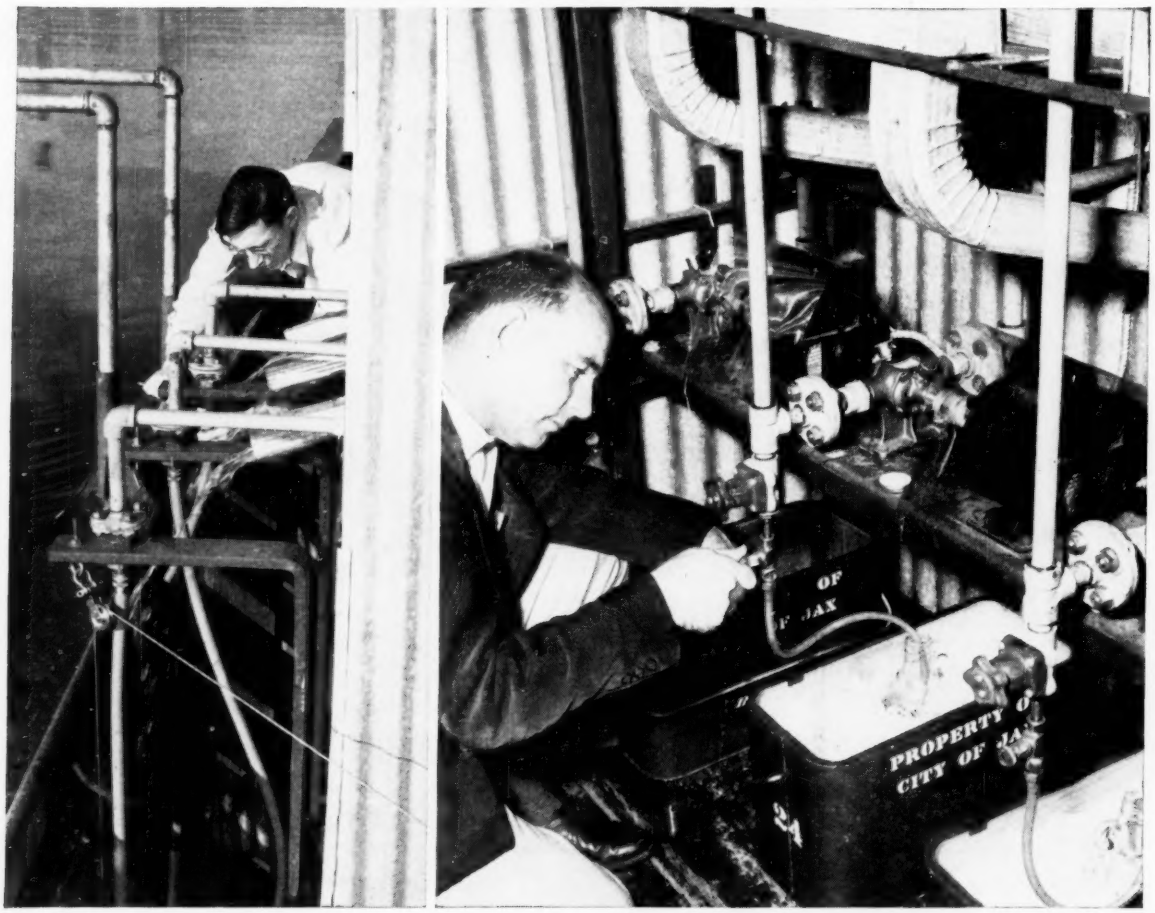

Koroseal helps analyze water in St. Johns River

IN a small building atop the Main Street bridge in Jacksonville, Florida are three motor-driven paddle pumps. Their job is to suck up water from the St. Johns River at three different depths—3, 38 and 72 feet—for use in continuing year-after-year laboratory analyses.

But chlorine content of the water runs high—reaching a maximum of 12,000 PPM at times—and so the pipes had to have unusual resistance to chlorides. That's why the City of Jacksonville chose B.F.Goodrich rigid Koroseal PVC pipe, valves and fittings. City engineers report continuous trouble-free operation.

Unusual application? Yes, but Koroseal rigid polyvinyl chloride pipe now provides excellent service in countless unusual applications where standard metal piping is inadequate. It's unaffected by most alkalies and acids, and is completely inert in the presence of oil, alcohol, and salt solutions. Unusually strong, it has high impact resistance and is available in tubes, rods, valves and sheets.

Other reasons for the growing popularity of Koroseal PVC are low initial cost . . . ease of installation . . . light weight . . . economical maintenance. It can be threaded, cut, welded or drilled —and never needs painting.

To get more information on how Koroseal can make your operation more efficient and profitable, fill in and mail the coupon to your right.

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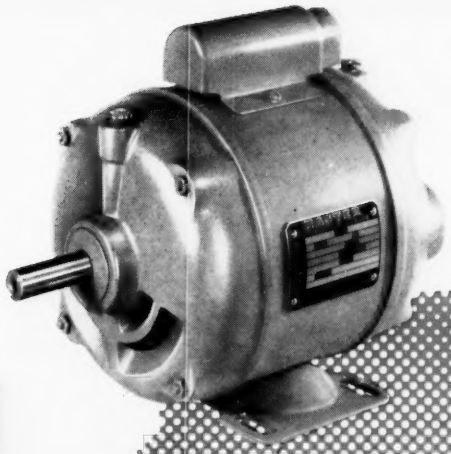

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You get a great big plus value with Master motors—fractional and integral H.P. And that is that every one of them is engineered to meet your drive requirements *exactly*—to combine, if desired, in one tidy, efficient package with other Master components.

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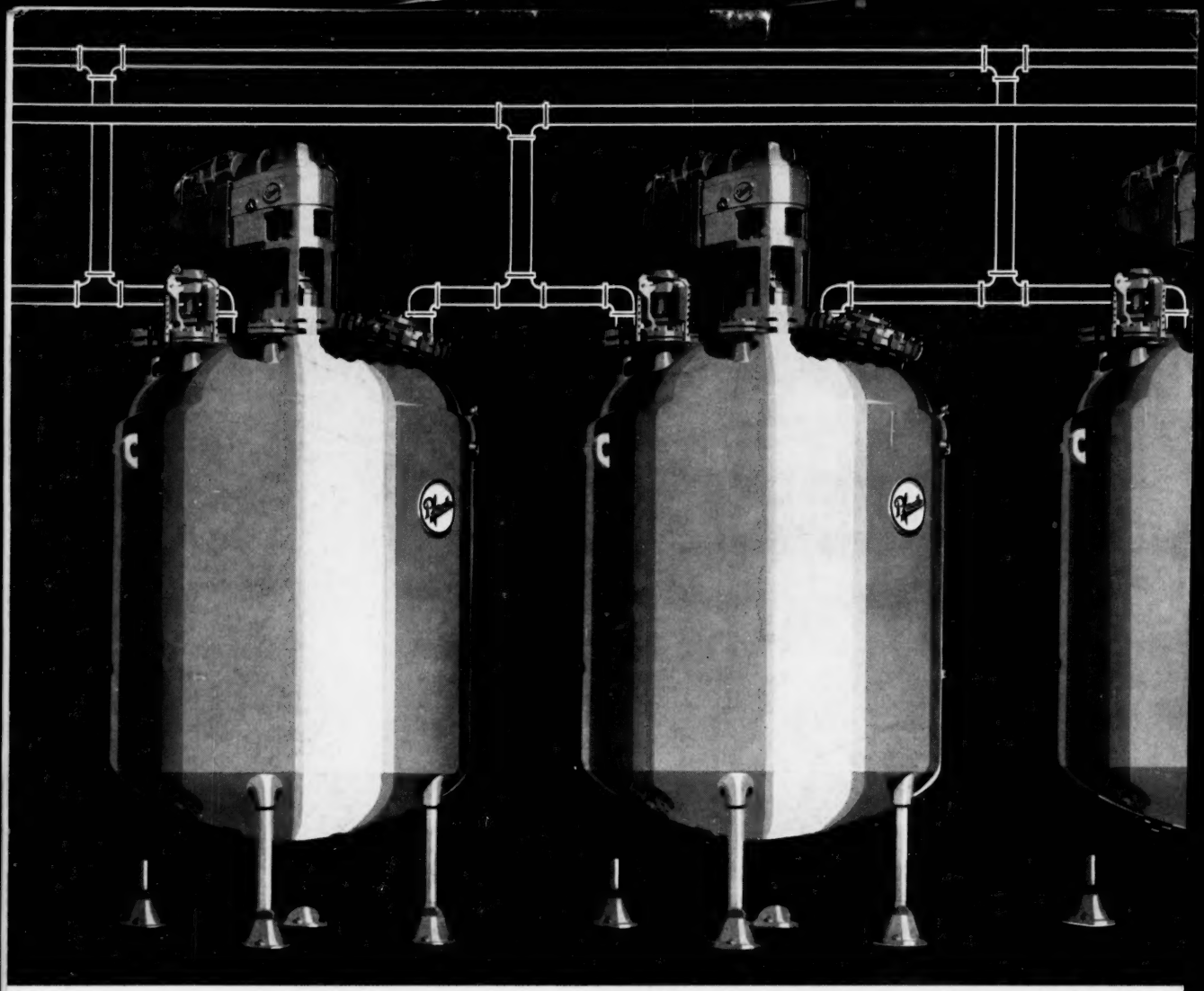
Speeds .....Single-speed, multi-speed, and variable speed.

Installation .....Horizontal or vertical, with or without flanges and other features.

Power Drive Features .....Electric brakes (2 types)—5 types of gear reduction up to 432 to 1 ratio. Mechanical and electronic variable speed units—fluid drives—every type of mounting.

THE MASTER ELECTRIC COMPANY • Dayton 1, Ohio

DIVISION OF RELIANCE ELECTRIC AND ENGINEERING CO.



Newest glassed steel reactor in 20 years. Units shown are 1000-gallon "R" Series, rated at 100 lb. internal pressure with 90 lb. jacket pressure. Higher pressures available on special order.

Side to side piping possible with new "R" Series Reactors

Hooking up glassed steel reactors takes less time, less head room, and less pipe when you use the new "R" Series.

There are an equal number of nozzles on each half of the top head, placed in such a way that they form mirror images. With such symmetry you could, for example, feed two reactors off a single tee pipe . . . one on its left side, the other on its right side.

New drive mount adds space, flexibility

The new "BH" drive is pedestal-mounted, takes up less space than tripod mounts. This leaves more of the top head accessible to nozzles, observation windows, manhole, etc.

Stuffing box or seal . . . changed in minutes

You can switch from stuffing box to mechanical seal or *vice versa* without disturbing the drive alignment. It takes just minutes to insert a preassembled, pretested "Pfaudlerpac" seal or stuffing box whenever you want to change.

Permanently and perfectly aligned

The base plate for the drive support is *welded* to the reactor in perfect and permanent alignment. All the interlocking components align directly to this plate, so you can assemble the drive without further leveling.

Both drive and stuffing box or seal have antifriction bearings throughout to maintain this precision alignment and to reduce wear. The bearing span is greater so you get little or no run-out.

Lapped nozzle surfaces

A special glass on all flange faces allows *lapped* surfaces for nozzles. No need to shim gaskets. You get truer gasket facings that result in safer operation at high pressures and reduce seepage which could corrode the tank exterior.

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